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The Rationale of Physical Therapy in the Treatment of Muscle Disorders*

Herman Chor, M. D.,** and Gertrude Beard, R. N.***

The treatment of muscle disorders has been based chiefly upon clinical experience. More recently, however, studies have been undertaken in the clinic and in the experimental laboratory in the attempt to obtain more precise knowledge as to the actual effects of the commonly used therapeutic procedures. It is the purpose of this presentation to review the plans of therapy recommended and to examine the rationale of such treatment. In addition, a few remarks will be made concerning the results of some original experimental work which we have been carrying on at the Northwestern University Medical School.

It may be helpful at this point to review briefly the subject of muscle disorders.[1] Based upon the underlying pathologic features, muscle disorders may be neurogenic or myogenic in origin. Neurogenic muscle disorders result from lesions of the motor peripheral or central nervous system, whereas myogenic disorders are due to changes arising directly and primarily in the muscle tissues. There are three chief types of muscle disorders: first, the upper motor neurone type characterized by a spastic paralysis, little or moderate wasting, and exaggerated reflexes; second, the lower motor neurone type, with flaccid paralysis, marked atrophy and diminished or absent reflexes; and thirdly, the primary myopathies. In this last group may be mentioned the muscular dystrophies, myasthenia gravis, amyotonia congenita (Oppenheim's), myotonia congenita (Thomson's) and other muscle syndromes which occur frequently enough to call attention to the fact that our present knowledge of them is extremely vague and inadequate.

The nature of the histopathologic changes present in the paralyzed or diseased muscle, in the intramuscular nerves and their endings, and in the intramuscular blood vessels determines in great measure the type of response to therapy that can be expected. In examining a weak or shrunken muscle by simple inspection and palpation through the skin, one should also bear in mind the actual histologic changes which give rise to its gross appearance and altered function. A primary muscle disease such as pseudo-hypertrophic muscular dystrophy presents a problem in treatment quite different from that of an anterior horn cell or peripheral nerve type of paralysis. Although there remains much to be learned concerning the histologic changes in the dystrophies and other myopathies, those occurring in the flaccid type of paralysis are very well understood. This presentation deals more specifically with the latter type of muscle disorder.

The lower motor neurone type of atrophy is seen particularly in anterior poliomyelitis and in lesions of the peripheral motor nerves. An outstanding feature of this type of paralysis is the rapid and severe wasting of the affected muscles. The cause of this atrophy, however, has not been definitely established although more recent experimental works have served to improve our understanding of this process. It has been found that the old view that paralyzed muscles atrophy as a result of inactivity alone is not valid. In a previous publication,[2] the nature of "simple disuse atrophy" has been described. The atrophy which occurs in a skeletal muscle not in use is very slow. As such it differs greatly from the rapid wasting which results from lower motor neuron lesions. Histologic studies show that simple disuse atrophy is associated with very simple structural changes. The loss of muscle bulk can be accounted for on the basis of a diminished quantity of sarcoplasm in the individual muscle fibers. The atrophied muscle fibers are narrower and are packed more closely together. The characteristic cross-striations persist. There is no actual degeneration of the muscle fibers, and the intramuscular nerves and nerve endings remain intact and of normal appearance. The intramuscular blood vessels likewise remain unaltered. It is well known that a return to activity brings about a rapid restoration of the affected muscles to their original bulk.

The muscle atrophy which occurs following nerve section or lesions of the anterior horn cell (poliomyelitis) is more than a wasting due to disuse.[3] It is very rapid in its course and characteristic changes occur. In addition to the shrinkage of the muscle fibers, degeneration of these cells follows. The cross striations disappear and a molecular and vacuolar breakdown of the muscle cells ensues. In later stages the disintegrated muscle cells are replaced by fibrous tissue and fat. A striking feature of this type of atrophy is the marked increase in sarcolemmal and muscle nuclei which takes place quite early, before the degeneration of the muscle fibers. These features are not observed in simple disuse atrophy. Fur-

*This work was carried on with the assistance of a grant from the Council on Physical Therapy of the American Medical Association.

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thermore, a critical feature of nerve section or anterior horn cell lesion atrophy is the alteration in the intramuscular nerve endings. The motor end-plates show changes characteristic of Wallerian degeneration.[4] In peripheral nerve lesions the muscle spindles also undergo degenerative changes. After one week of denervation there are few nerve endings to be seen. This is in marked contrast to what is found in simple disuse atrophy, even of very long standing, in which the nerve endings remain intact. Of some significance also is the reaction of the intramuscular blood vessels in lower motor neurone lesions. Capillary dilatation, endothelial hypertrophy and eventually fibrosis can be clearly demonstrated.

Langley[5] postulated another theory to explain the wasting of denervated muscle, namely that it is caused by fibrillation of the muscle fibers. This activity was thought to cause exhaustion of the muscle fibers and hence result in wasting. He later altered this idea inasmuch as he recognized that there was no definite evidence to support it. He admitted that fibrillation may be an accompanying phenomenon rather than the cause of the atrophy. But as late as 1930 Stevens[6] supported this fibrillation idea and stated that "in view of the fact that the muscle is in a state of prolonged fibrillary activity, it follows that it requires physiological cellular rest and not stimulation. To attain this end a search should be made for chemical or other means of checking fibrillation." In our experience fibrillation is rarely observed in the paralyzed muscles resulting from nerve injury.

More recently Gerard[7] studying the process of degeneration in the severed peripheral nerve postulated two possibilities: "Either the normal conduction of impulses is necessary to maintain the nerve in normal condition or substances reaching the fiber from the cell body, particularly the nucleus are necessary to its continued survival." He found that regular stimulation of the peripheral end of a cut sciatic nerve in dogs hastens rather than delays loss of function. Inasmuch as the blood supply is unaltered nutritional substances, oxygen, etc., carried by the blood are amply supplied, therefore, the lack of them cannot be the factor in degeneration. He assumes that some agent, a "neurogenic metabolite," or enzyme, might well be formed only under nuclear influence and is supplied to the peripheral fiber by spreading along it in the manner of the spread of a virus. The peripheral end of the cut nerve degenerates because it is unable to maintain its basal metabolism in the absence of this agent. This "trophic influence" has been thought to extend even to the specific tissue supplied by the nerve. It has been suggested therefore that the atrophic and degenerative changes that occur in denervated muscle are due to the lack of this "neurogenic metabolite." It should be emphasized that no definite proof is available for the above hypothesis.

In considering the above explanations for atrophy of paralyzed muscles it appears that "inactivity" is certainly *one* factor playing a part in the wasting process. It has been pointed out above that disuse alone *does* result in some degree of atrophy. The amount and type of atrophy of muscles paralyzed as a result of damage to the anterior horn cell or its peripheral processes, however, cannot be explained by "disuse" alone. Some additional factor or factors must be playing a part. Gerard's idea of a "neurogenic metabolite" deserves consideration, but experimental proof must be offered before such an idea can be accepted as a scientific fact.

From a clinical standpoint, atrophy has been the feature receiving most attention in dealing with paralyzed muscles of the flaccid type. Pollock and Davis[8] have pointed out, however, that demonstration of atrophy in terms of wasting of a muscle is not an accurate guide to the severity of the lesion. Atrophy is of service in denoting the severity of a lesion only when it is present soon after injury. It should be emphasized that the degree of muscle degeneration and fibrosis and the amount of functionally preserved muscle fibers are the important determinants in the future restoration of the muscle when re-innervated.

The measures commonly employed in the treatment of flaccid paralysis are electrical stimulation, passive movement and massage, heat, rest and muscle reeducation. The exact indications for the use of these procedures alone or in combination, however, are still a subject of controversy. According to many workers, electrical stimulation is contra-indicated in the early stage of poliomyelitis. They advocate rest. Others stressing the rapid rate of atrophy and degeneration maintain that something should be done to prevent, insofar as possible, the progress of atrophy and fibrosis. They decry rest and advocate light massage and passive movement. A review of the literature reveals considerable confusion and disagreement regarding the value of these measures, their indications and contra-indications.

The Role of Electrotherapy in the Treatment of Paralyzed Muscles: Normally every healthy muscle reacts to both the faradic and galvanic current. In lesions of the lower motor neurone, these responses are altered to a degree depending upon the extent of the nerve-muscle degeneration. Completely denervated muscle, however, continues to respond to galvanic current. This fact has been utilized in the treatment of flaccid paralysis inasmuch as it was believed that *inactivity* was responsible for the muscle atrophy. By stimulating the paralyzed muscles with galvanic current, an artificial stimulus is substituted for the normal voluntary impulse. The earliest experimental works on this problem were those of Reid[9] and of Brown-Sequard[10] on frogs and rabbits. They reported that daily electrical stimulation prevented atrophy of muscles paralyzed by nerve section. This idea held sway until Langley and his associates repeated the experiments using rabbits and found that wasting of the paralyzed muscle progresses despite daily stimulation by galvanic current. It is well known that nerve fibers severed from their cells of origin undergo Wallerian degeneration. Cook and Gerard[7] recently repeated the experiments of Langley and Anderson[11] and of Bethe[12] and confirm their findings that stimulation of the peripheral portion of the severed nerve caused a more rapid loss of irritability and conductivity than the companion resting ones. The nerve degenerated more rapidly. They concluded that the integrity of the nerve fiber is dependent upon some type of chemical substance spreading along it from the nerve cell, rather than on any type of transmitted activity.

Does electrical stimulation prevent muscle atrophy? A series of experiments was recently carried out at the Northwestern University Medical School by the authors and associates. Using macacus rehesus monkeys, the gastrocnemius-soleus muscles were paralyzed by sectioning the sciatic nerve. The severed nerve was sutured immediately following section to aid in establishing the best pathway for the regenerating nerve fibers. In one experiment both sciatic nerves were cut. One side received daily electrical stimulation (10 contractions, galvanic current), the other no treatment. At the end of six weeks the treated side showed just as much atrophy as the untreated; indeed, there was slightly more wast-

ing on the treated side. In another experiment three groups of monkeys in whom one sciatic nerve had been severed and sutured were treated as follows: one group received daily electrical stimulation (10 contractions, galvanic current), another daily passive movement and massage and the third group rest by immobilization in a plaster cast. At the end of six weeks it was found that the amount of atrophy was practically the same in the three groups. We conclude therefore that muscle atrophy following nerve section in the macacus rehesus monkey progresses up to a period of at least six weeks despite treatment by electrical stimulation, by passive movement and massage, or by rest. We wish to emphasize that these findings deal only with the *amount* of *atrophy*. Studies are now in progress with a view toward establishing the status of the treated muscles, as to their histologic structure, the amount of degeneration and the degree of regeneration.

There is considerable literature on the subject of the effects of electrical stimulation of paralyzed muscles. Electrical stimulation causes the muscle to contract. As a result of this contraction the blood is squeezed out of the muscle and passed into the venous system and arterial blood rushes into the muscle on relaxation to be forced onwards at the next contraction. Wolfson[12] studied experimentally the effects of electrical stimulation on blood flow in the normal limb and concluded that it is the contraction per se, regardless how induced, that causes a mechanical change in the blood flow. He found no evidence that electrical stimulation caused a change in the size of the blood vessels as a direct effect. Smart[14] has stated that no virtue or curative power whatever is claimed for the use of electricity per se. Electricity is merely a means to an end and is made use of as the stimulus which produces the desired contraction. It is solely as a result of this contraction with all the attendant chemical and circulatory changes that the beneficial results are obtained. Stookey[15] likewise calls attention to the fact that the chief value of the contractions produced electrically is in the improvement of circulation which maintains nutrition and aids in the removal of waste products.

Roberts[16] assumes that contractions of the muscle fibers produced by electrical stimulation produces internal movement within the muscle itself maintaining a condition of mobility in the sarcoplasm and prevents fibrosis during the regeneration of the sarcostyle. Brown-Sequard very early expressed the idea that associated with activity of the muscle fibers certain chemical changes may occur as a result of a "nervous agent" and that galvanic current besides keeping up the muscle weight by contraction may have some similar action on the chemical changes. There is no evidence to lend any support to such an hypothesis.

Tinel[17] says that the simple passage of the electric current appears capable of hastening the regeneration of the nerve, maintaining the nutrition of the tissues and facilitating the resolution of the cicatrical fibrous tissue. He then adds: "However great the therapeutic resources of electricity we must not forget that massage and mechanotherapy are absolutely necessary to supplement them. To maintain the contraction of paralyzed muscles, to prevent its fibrous transformation, massage is perhaps as important as electrotherapy."

According to Sir Robert Jones[18] it is probable that the time taken for regeneration of axis cylinders is not affected by any specific method of treatment, electrical or otherwise, and the treatment is directed to maintaining or regaining nutrition and function in the muscles and joints supplied by the damaged nerve. In the same article, however, he states that electrical stimulation prevents the complete atrophy of the denervated muscle and maintains the muscle in such a state that when the axis cylinder has grown to the muscle, the latter can at once begin to resume its function.

Massage and Passive Movement Therapy in the Treatment of Flaccid Paralysis: Massage has long been recognized as an important and valuable form of therapy in the treatment of paralyzed muscles. Mennell[19] calls attention to an instinctive desire for massage as exhibited by animals when injured. He cites as an example the commonly observed licking movements applied by the dog to his injured leg. This no doubt gives rise to some feeling of comfort or beneficial effect. The alleged benefits of massage, however, have been based upon careful and sound physiologic investigation. It has been demonstrated that massage may exercise a mechanical and a reflex effect. Its chief mechanical effect is upon the blood circulation.

That massage increases the blood flow in the extremity has been proven experimentally by many investigators (Rosenthal,[20] Wolfson,[13] Brunton and Turncliffee,[21] etc.). Clark and Swenson[22] demonstrated by cinematographic studies that following massage there is an increased rate of blood flow. Massage mechanically emptied the veins and encouraged the inflow of arterial blood.

It has been found that massage assists the venous return and also the lymph flow. As a consequence the vascularity of the part is improved and the elimination of waste products is hastened. The experiments of Von Mosengeil[23] demonstrated the effects of massage upon absorption by the circulation of foreign matter. He injected joints with Chinese ink and showed the removal in the massaged parts as contrasted with untreated parts. More recently McMaster[24] injected vital dyes intradermally and showed that massage does stimulate lymph flow. The value of this influence of massage on the end-products of metabolism is of considerable importance in the treatment of muscle disorders in which their dysfunction is associated with the accumulation of products of dysfunction. The removal of some of these substances by massage is highly desirable.

Hartman, Blatz and Kilborn[25] using dogs found that denervated muscles which were treated by daily massage over a period of seven to one-hundred and ninety days showed a greater work capacity than untreated muscles. The massaged muscles were stronger than the controls in 62 per cent of the animals treated. It is interesting to note also that there was considerable discrepancy between the comparison by weight and the comparison by function. As mentioned above, a muscle may undergo considerable wasting and yet if fibrosis is at a minimum and the circulation and nutrition good, this small muscle may show greater power than a muscle of greater weight which weight, however, is due to overgrowth of fibrous tissue and undesirable by-products of dysfunction which interfere with the function and regeneration of the remaining healthy muscle fibers.

The value of massage in restoring muscular vitality has been proven experimentally by Zabludowski.[26] He found that when a muscle had been completely exhausted by repeated contractions in response to faradism, subsequent rest had relatively little effect in restoring the power of contractility. After massage (kneading) this power returned very swiftly, presumably because the waste products of muscular metabolism had been dispersed. Pemberton[27] calls attention to the difference

between active muscular exercise and passive muscular exercise in the form of massage in regards to lactic acid formation. Massage gives rise to an insignificant rise in lactic acid whereas active exercise develops lactic acid and hence a systemic acidosis. He calls attention also to the beneficial effects of massage on over-exercised muscles of athletes. It appears that the changes in the blood supply of muscle brought about by massage permits presumably more rapid or more thorough removal of the lactic acid already contained within such tissues.

Passive movement is usually employed along with massage and is invaluable in the treatment of paralyzed muscles. Its purpose is to maintain suppleness, to prevent fibrosis and adhesions and consequently prevent contractures. In addition, the circulation of venous blood and of lymph is assisted materially and hence the removal of waste products, of extravasation and of edema is hastened. Of particular importance are the beneficial effects of passive movement in preventing fibrosis of the joints as well as within the muscle bundles. Mennell[19] notes that passive movement helps to preserve "joint sense" and "muscle sense" through stimulation of the afferent sensory nerve fibers. Others state that passive movement also aids in preserving the elasticity of the weakened or paralyzed muscles and prepares them for active movement when regeneration of the nerve occurs.

The effects of massage and passive movement therapy upon regeneration of paralyzed muscles was studied experimentally by the authors in the following experiment. Two groups of animals (macacus rehesus monkeys) were subjected to unilateral section of the sciatic nerve. These nerves were immediately sutured to assure good alignment for regeneration. After a rest period of four weeks during which time splintage of the paralyzed muscles was accomplished by immobilization in a plaster cast (the muscles kept relaxed by flexion at the knee and plantar flexion at the ankle), one group received daily massage and passive movement therapy; the other group of animals was kept at complete rest by immobilization. After a period of time varying from two months in some animals to six months in others the muscles were examined.

The marked recovery of muscle weight in those animals treated by massage and passive movement as compared with those given complete and prolonged rest is well demonstrated. In addition to this quantitative effect the muscles which were kept at rest showed extreme fibrosis and tendency to contracture. Fibrosis of the joints also was marked. The massaged muscles, however, were supple and elastic and there was considerably less fibrosis and adhesions than in the muscles which were immobilized.

Rest as a Therapeutic Procedure in the Treatment of Flaccid Paralysis: Rest has taken its place as a definite therapeutic procedure in the armamentarium of the physical therapist. Recognizing the prompt alterations in the structure of skeletal muscle following damage to its nerve supply, most clinicians favor rest during the early stage of paralysis. This does not mean to leave the paralyzed muscles alone. Rest must be accomplished in such a manner as to avoid stretching the denervated muscle. Stretching of such a muscle may result in irreparable damage. Splintage, therefore, is indicated in order to prevent this complication. MacKenzie[28] has stressed the importance of rest in the early stages of paralysis in poliomyelitis. He has written "The fallacy that we must do something to the muscle 'to maintain its nutrition' would appear to be dying as hard as the one that by resting a joint its liability to ankylosis is increased. If a motor nerve be injured, the injury has also affected the muscle and how can we expect recovery of the muscle after repair of the nerve if we fail to rest the muscle? Not only is muscle rest the most effective agent for repair of injury or inflammation of either muscle itself or of the nervous system with which it is connected, but the position of rest is the physiological basis for the re-education of muscle function." Todd[29] warns that a paralyzed muscle that is stretched will not recover. Therefore, he recommends in the acute stage of poliomyelitis complete rest and relaxation. Legg[30] also advocates complete rest and immobilization with limbs in the neutral position in the early stage of poliomyelitis. He warns, however, that in immobilizing an extremity the neutral position should not be held so continually or the joint may become stiff. Relaxation of a partially paralyzed muscle facilitates restoration of function while stretching favors further paralysis.

On the other hand many authors are opposed to rest on the grounds that the circulation in a paralyzed muscle is diminished and sluggish, thereby allowing the waste products of dysfunction to remain stagnant within the muscles. In addition the process of fibrosis which follows closely upon atrophy and degeneration of the muscle fibers gives rise to adhesions within the fibers whereas movement tends to free the muscles from such adhesions. Others claim also that movement would overcome the atrophy of the paralyzed muscle and restore strength.

Coulter[31] calls attention to the fact that although muscle has been looked upon as a hardy tissue, the paralyzed muscle is very delicate and that great judgment and patience are required in treatment. Mennell[19] also comments that because of poor muscle tone the intramuscular blood vessels may be readily reached by massage and may be damaged by too vigorous a rubbing. He warns against squeezing the muscle fibers which are unable to protect themselves between the massaging hand and the bony structures within the limbs. "The gentlest touch is all that is required to drive on the fluids in the venous and lymphatic circulation."

Heat is recommended as an adjunct to treatment. Its effect is primarily to increase the circulation of blood in the area and thus make more effective the other forms of treatment; that is, massage and electricity.

As soon as voluntary pathways have been established by regeneration of the peripheral nerve, muscle reeducation should be instituted. Underwater exercises have proven beneficial for building up muscle power in the regenerating muscle.

SUMMARY

Thus it may be seen that there are many problems relating to the treatment of flaccid paralysis. Our studies have shown that atrophy and degeneration of muscle fibers result from damage to the neural portion of the motor apparatus. These changes in muscle are as inevitable as those changes which occur in the peripheral portion of a severed or damaged nerve. We need not anticipate that a mechanical procedure is going to check this natural process. We have seen, furthermore, that atrophy is not the all important feature of the lower motor neurone type of paralysis. Fibrosis is the chief factor which determines the fate of denervated muscle. The invasion of any organ by excess of fibrous tissue results in cirrhosis, and eventually damage to the remaining parenchyma. Inasmuch as muscle regenerates by outgrowth from the remaining healthy muscle cells,

the importance of preserving the parenchyma is obvious. What we wish to accomplish by treatment is to maintain the muscles in the best state of nutrition and vitality so that when regeneration of the nerve occurs the restoration of the muscle which follows will be at a maximum. This can be accomplished best by (1) encouraging good circulation of blood and lymph to keep nutrition at its best and to carry off the waste products of dysfunction, and (2) by keeping at a minimum the fibrosis, which soon follows atrophy and degeneration. In the early stage of paralysis rest is indicated with splintage of the weakened muscles to prevent stretching. As soon as possible, however, light massage should be started to promote adequate circulation. In the later stage when fibrosis is beginning to occur, passive movement and massage and electrical stimulation should be utilized. The beneficial effects of passive movement and massage in preventing fibrosis and contractures have been conclusively demonstrated. The worth of electrical stimulation, however, is in need of further investigation.

There is a definite need for more studies on muscle regeneration and the effects of various agents on the amount and quality of this regeneration. Until such information is forthcoming a conservative plan of therapy which aids the natural processes of repair seems indicated. Those measures which can accomplish this with the least likelihood of harmful complications would appear to be the treatment of choice.

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The Technic of Joint Measurement in Physical Therapy*

Frank J. Wiechec, B. S.

Measurement of the range of motion of a joint is of vital importance in treatment. Accurate measurements of joint motion furnish objective facts on the basis of which the patient and physician may gauge the improvement or lack of improvement in the course of treatment, instead of relying on subjective impressions. One of the greatest values of joint measurement lies in the psychologic effect on the patient in interesting him in the progress of his own case. The measurements of the first day show him the extent and the nature of his injuries as compared with the record of a normal individual. Succeeding measurements show how rapidly he is improving and indicate how long treatments will be necessary. In daily practice such measurements furnish the best possible guide to the direction of the treatment itself, and, finally, when the treatment is finished, they furnish reliable data by means of which results can be stated and studies can be made. They are also indispensable in medicolegal work: Rosén stated, "Exact knowledge of the extent of disability present is of paramount value. Laws providing compensation for injuries sustained in industry are becoming well nigh universal, and the physician is often the sole arbiter as to the amount of disability present. The justice of the compensation awarded depends on the accuracy of the records."

Joint measurement is of value in the treatment of arthritis in its various forms, of fractures, of dislocations

*Read before the meeting of the American Physiotherapy Association, Rochester, Minnesota, July 1, 1937.

Section on Physical Therapy, The Mayo Clinic, Rochester, Minnesota.

and of joints stiff after operation. These diseases usually respond very slowly to treatment and often require changes in the treatment itself. Without some means of control and comparison, progress and rate of recovery could not be gauged. In order to have accurate and uniform measurements there must be a definite and clear method for measuring joints. An instrument that can be used to measure all joints, and a simple method of recording measurements, are important in keeping accurate records.

SYSTEM OF MEASURING JOINTS

The system of measurements which is now in use at The Mayo Clinic is based on the half circle arc. Movements are measured either from 0° to 180° or from 180° to 0°. Wherever the part stops in its course on the half circle scale, the number opposite it indicates the degree of motion. The number of degrees stated, as will appear in the records, indicates the limit of motion on the half circle scale and not the amount of motion. If it is desired to state the flexion or extension of a joint it is stated that movement in flexion is to a certain degree or that movement in extension is to a certain degree on the scale.

The zero end of this arc is toward the head and the median line of the body. As movement approaches the head and median line, the angle of the joint becomes smaller and the reading on the scale lower. Motion away from the head and median line will increase the angle and the reading on the scale will be higher. In measuring rotation including pronation and supination, the zero end is toward the median line of the body. Internal rotation is toward 0° and external rotation toward 180° on the anterior half circle arc in the transverse plane.

Extension is movement toward 180° and flexion toward 0° on the half circle arc in the anteroposterior plane. Hyperextension is movement toward the head and measurement will read from 180° to 0°. Measurement of adduction will read toward 0° and of abduction, toward 180°. If it is desired to determine adduction or abduction of the arm, the measurements are made with the arm prone in the lateral plane.

NOMENCLATURE

At present there is a great deal of confusion among physicians and technicians in describing joint movements because of the variety of terms used to describe the many movements of the bony articulations of the body. This confusion is evident in the thirty-seven terms used to describe the movements of the humerus (shoulder joint). Some of these terms were "coronal," "sagittal," and "median" planes; "pivotal position," "inferior," "superior," "adduction" and "abduction." Such ambiguous phrases as "circumduction," "rotation," "elevation," "flexion," and "neutral" also are used in describing movement.

In order to avoid such confusion at the clinic, each movement of the various joints of the body has been defined and given a name. Charts are posted in each room outlining the system of measurements and the nomenclature to be used. Approximate ranges of motion are also given for each joint.

VARIOUS METHODS OF RECORDING JOINT FUNCTION

It is generally accepted that measurements of joint movement and deformity should be recorded and obviously the records should be intelligible. These records serve a purpose similar to that of the temperature chart or sphygmographic or electrocardiographic reading. Various methods of recording measurements are used by the medical profession; these range from notations of the deformity or extent of limit of motion, hastily scribbled on the patient's record, to the elaborate photographing and graphing of degrees of motion. The following methods of recording are used frequently.

Photographs.—The usual method of recording joint function is to take a picture of the part at the time treatment is begun to show the extent of movement that is possible. Photographs are then taken at regular intervals and at the time the patient is dismissed. Comparison of such pictures not only will show the progress of movement of the part, but also his general condition, the amount of atrophy, the degree of deformity and so forth. This method is satisfactory but is costly and time consuming.

Schematograph.—This is a comparatively new method of recording movement. The part is placed before a white background, with lights focused on it from two directions. An outline is traced while the part goes through all of its ranges of motion. Tracings can be made at frequent intervals and comparisons made to note the amount of improvement that has taken place. With this method the various movements of the part can be recorded easily on one piece of paper. The apparatus used for recording consists essentially of a box, in which is mounted a camera lens; a mirror to reflect the image is mounted inside the box and a piece of clear glass is placed over an opening above the mirror. A piece of tracing paper, placed over the glass, will bear the image of the part; and this image can be traced on paper. The one difficulty in this method is that unless the recorder has had some skill in drawing or illustrating, the diagrams will not be very accurate.

Graphs.—This method is used frequently by physicians and technicians in recording the amount of motion and degree of improvement. In order to insure clearness, a key to the graph or some explanation of the curves must be given.

Diagrams.—Nutter stated; "Greater use should be made of graphic records in the interest of clearness. Diagrams will make plain what we mean, even though we differ in our terms. These graphic records take very little time to sketch free hand. If actual measurement in degrees of a joint is wanted the sketch is used and the angles are measured. Here again, unless the illustrator can make his diagrams clear, the records will not be intelligible.

Simple recordings.—A simplified method of recording, used by many, is merely to write in the patient's record, at the time of measurement, the part, the movement being measured and the findings. For example, for the right elbow: flexion to 130°, extension to 180°; range of motion 50°.

APPARATUS

The necessity for treating and recording disabilities sustained in the World War stimulated the development of a great many instruments for measuring the amplitude of movements of various joints. Nearly as many instruments have been devised as there are joints in the body; among them are goniometers for measuring motion of the knee joint, protractors for making similar measurements at the shoulder joints, fleximeters for determining motion of the elbow, ankle, wrist and finger joints, and special instruments for measuring supination and pronation. These instruments also have been used to measure the amount of angular deformity of a fracture in a roentgenogram and occasionally they are used in designing braces.

Such instruments vary widely in design. Some are elaborately constructed of metal framework and demand a special technic for accurate use; others are simple copper or wooden frames that fit over, or about, the limb and have a dial from which readings can be made. According to Robinson, the original instrument for measuring joint movement was a protractor so modified that it could be used on all of the extremities. It consisted essentially of two arms: to the end of one of them was attached a protractor scale while the end of the other arm was shaped to a pointer. These arms were connected at the axis of the scale so that the pointer registered against the scale.

CONCLUSION

There is definite need for a systematic and uniform method of measuring and recording joint motion. This is clearly shown by records of medicolegal cases, industrial compensation boards and statements of physicians. Because of lack of uniformity in records and in methods of measurement, confusion is found. This can be alleviated if a definite system of measurement is followed. Nomenclature and methods of recording should be clear and understandable to all who are working in a department of physical therapy.

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Massage Methods*

Kathryn R. Wiechec, R. N.

Massage is an ancient art. We are all familiar with its history and the different movements that comprise it. It matters not whether we give so-called Swedish massage or English or German massage, or any combination of these. The point is, we should know what our aims are and the objects of our treatment. A thorough background of anatomy, physiology and pathology is essential so that we can understand the processes the body undergoes when massaged.

Most of our work at the clinic calls for local treatment; very few complete massages are given. Some patients come for one or two treatments, and it is necessary to teach them how to continue treatment at home; others we treat for weeks and sometimes months.

We are especially fortunate in having physicians who prescribe the type of massage to be given. Our charts read: "massage—light or deep sedative," "light or heavy stroking," or sometimes, "light or heavy stimulative massage." There is a tendency among technicians to apply the same amount of pressure, the same number of strokes and movements day after day regardless of the disease they are treating or the condition of their patient. In other words, treatment is not varied to meet the individual needs. Technicians should keep in mind that a patient may need a little more stroking to relieve edema or a firmer massage to increase deep circulation than he did the day before. This must be watched if massage is to be given intelligently.

In our department we treat practically every disease in which massage may be used. For some diseases we have found that a definite technic is necessary for proper treatment. The following diseases, for example, demand special technics:

FIBROSITIS

Widely recognized abroad, fibrositis has, until recently, received but scant attention in this country. Fibrositis signifies an inflammation of white, supporting tissue and may, therefore, occur almost anywhere in the body. The two most common types of fibrositis are intramuscular and periarticular. Fibrositis particularly affects the lumbosacral, gluteal, or sacro-iliac regions, the shoulder girdle, cervical, or upper thoracic regions, and the trapezius muscle. It is characterized by tender spots that may come and go and that shift positions. Associated subcutaneous thickenings or definite nodes often are palpated. Some authorities believe that fibrositic nodules contain a large amount of toxin which is set free in the circulation when the nodule is forcibly broken down. The number of nodules broken down at one treatment must therefore be limited so as not to produce a reaction.

Those most experienced in the treatment of this condition recommend rather strenuous massage over the tender regions. A light sedative massage is first given to relax the muscles and to prepare the way for the deeper, more strenuous massage. The fibrositic nodules or thickenings are located by palpation with the finger. Special friction is then given with several fingers, the thumb, or the heel of the hand in a circular and to-and-fro movement with the weight of the whole body thrown into the work. This continues for several seconds or minutes, depending on how much the patient can tolerate; deep and soothing strokes are then given to ease the pain and to increase the circulation, following which more special frictions are given. Such measures are usually very painful and the patient can tolerate the treatment for a limited time only. If the area is still tender and sore at the next treatment, only deep sedative massage should be given. When the tenderness has subsided somewhat the thickenings must again be attacked until they are finally broken up and absorbed by the blood stream.

DUPUYTREN'S CONTRACTURE

Dupuytren's contracture is a contracture of the palmar fascia causing the fingers to fold into the palm. Mennell[1] wrote: "Dupuytren's contracture can, I firmly

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*Read before the meeting of the American Physiotherapy Association, Rochester, Minnesota, July 1, 1937.

believe, be prevented from causing deformity if the trouble is detected early enough and the patient is instructed to perform for a few minutes, twice a day, deep kneading of the palm and simple stretching of the fingers." If the contracture has progressed to a point where the palmar fascia has become a thick mass of scar tissue, operation must be resorted to.

The postoperative treatment divides itself into three stages: the application of proper splints, the use of heat, massage and manipulation, and the prevention of recurrence of the deformity. The first stage, the period of rest and splintage, lasts for from ten to fourteen days. In the second stage the stitches are removed and heat and light sedative massage are given to remove edema. The heavy fibrotic scabs which are found around the site of the skin incision should not be touched at this time. Friction or heavy massage should not be given on or around the incision until after the fourth week. By this time there is little danger of causing drainage and consequent infection or injury to the dissected nerves. Very gentle passive movements of the fingers should now be instituted. In the third stage (which is approximately four weeks after operation) the hand and forearm can be immersed in the whirlpool bath. Deep sedative massage is then given with light frictions over the scar tissue after the firm scabs have fallen off of their own accord. The amount and force of friction should gradually be increased to keep the palmar tissue soft and pliable. After a sufficient length of time the patient is instructed for home treatment and is shown how to apply the kneading and friction to his palm and arm; he is also instructed in extension and flexion exercises and is warned to avoid repeated trauma to the palm.

UNDERWATER MASSAGE

In our Hubbard tank many patients are given massage under water. It is extremely difficult to give stroking movements, however, as the hands have a tendency to slip. Since we treat mostly arthritic patients in the tank, we endeavor to relax the muscles to gain increased motion. We have found that the application of a small amount of mineral oil to both hands greatly facilitates massage. There is then little jarring or slipping. If just a small amount of oil is used it will adhere to the patient's skin and will not make the tank oily. Mineral oil is now used routinely for this work.

SCAR TISSUE

It is our practice in the treatment of scar tissue to avoid the use of any lubricant. The fingers or thumb move in small circles, the skin being made to slide over the underlying structures. Even though no lubricant is used the skin will not become abraded if friction is applied properly.

LUBRICANTS

We routinely use talcum powder (unscented). At first we used a brand put out by a standard medical house but found that this was too expensive. Now we use a fine grade of Italian talc, which is much better and which is considerably less expensive. Powder is pleasant to use. Patients seem to like it and it is preferred during warm weather. Some objections to powder are that it irritates the skin, has a drying effect if used continuously, and is unsatisfactory on hairy surfaces.

Olive oil.—This is a good lubricant but is rather expensive. Some patients object to its odor and, because it is a thin oil, technicians are inclined to use too much of it in massaging.

Mazola oil.—This has been used as a lubricant in place of olive oil. It was satisfactory, but it has had to be discarded because of its effect on the linen. It stains the linen with a dirty yellowish color which does not come out with laundering.

Mineral oil.—Mineral oil is an exceptionally good lubricant and is inexpensive. It is very good if a deep, kneading massage is ordered.

Cocoa butter.—This is another good lubricant. It has a softening effect on the skin and is especially good for hairy surfaces. It seems to be more readily absorbed than other oily substances and is recommended for use following the removal of plaster casts. A patient is found occasionally who objects to the odor, and in warm weather it has the tendency to melt quickly.

Cold cream.—Cold cream is a fair lubricant, but a good grade is too expensive for ordinary use.

We have tried all these lubricants, but we now use talcum powder, cocoa butter and mineral oil routinely.

CONCLUSIONS

Regardless of what lubricant is used, the hands giving the massage are the important factor. The value of a keen tactile sense cannot be overestimated. One cannot massage properly by just going through the motions while one's mind is on something else or while one casually chats with the patient. A considerable degree of concentration is essential. When giving massage the following points should be kept in mind: the quality of the tissue acted on, the general condition of the patient, the form of the muscle or muscular group and the outline of the bone underlying them. Only in this way is it possible to give massage intelligently.

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During the Mythical Period (Antiquity to 96 B. C.) surgery appears to have been on a very low level. Sawdust was strewn upon open wounds and burns were treated by painting them with the juice of the Venus muscle. Bloodletting appears to have been known at this time. Mineral baths and douches of water were frequently employed.—*From "JAPANESE MEDICINE" by Y. Fujikawa, M. D.*

Residual Neuromuscular Hypertension: Implication for Physiotherapy*

Part IV: Possible Causes As Well As Consequences of Excess Tension

Josephine L. Rathbone, Ph. D.

In the first three articles of this series, emphasis was placed upon what residual neuromuscular hypertonus means in physiologic terms. In the last three articles, emphasis will be placed upon the causes as well as consequences of this hypertonus, as interpreted from a study of clinical cases.

The author was careful to weigh all etiological possibilities suggested in the literature to date on the subject of fatigue with its phases of hypertension and exhaustion. She was careful to delay judgment as to the important factor or factors in every case analyzed, however, until she had had an opportunity to watch it for several months and until there was definite relief. These cases have been described in the formal presentation of the dissertation material. An exhaustive bibliography on the subject also accompanies that presentation. In these articles, in consideration of space, it will be necessary to generalize from the findings of the dissertation.

General Appearance—Distinguishing Features. Outward signs of residual neuromuscular hypertonus are varied and less obvious than the layman supposes. Very often, in the cases studied, the face was mask-like with an expression that varied from a set smile and fixed stare to a wrinkled brow; and the body was held in control. At any rate, fidgeting was not characteristic of our cases.

Perhaps excess muscular movements, like wiggling of fingers and tapping of toes, are to be recognized as the expression of efforts on the part of individuals to prevent inactivity which they dread and which is uncomfortable when accompanied by tension. Furthermore, any blinking of eyes, twitching of mouth, or grimacing may act as a relief mechanism for a state of mental tension with its accompanying muscular hypertonus.

A characteristic which an examiner interested in physical therapy would notice particularly is that, in the cases exhibiting persistent nueromuscular hypertension, the muscle configuration was firm, rounded, and well defined, in contrast to the indefinite contours and flaccid quality of resting muscles of the ideal athlete. A casual observation of a tense individual in the execution of movements which are at the limit of his capabilities serves to demonstrate, also, the inelasticity of his muscles and thus the inflexibility of his joints.

Postures. Numerous students of industrial fatigue as well as physicians and physical educators have warned against what they have called "poor posture." It has been contended that improper "posture" reacts on all organs and the spine; and, in the case of the respiratory organs, decreases the amount of available oxygen and the elimination of carbon dioxide. It has been claimed that in "poor posture" general circulation is impeded; the abdominal organs are forced downward, causing a ptosis; the work of the liver is interfered with, causing jaundice; and the spleen is affected in a manner to cause anemia.[1] Chairs for work and chairs for rest have been devised for industry, the schools and the home, all purposing to keep the body from slumping.

The danger, however, is not only in skeletal slumping of the body segments but also in tense muscular holding of the body segments in whatever position is assumed.[2]

The human skeleton is so loosely articulated that every posture necessitates considerable tonic muscular effort. Every posture becomes fatiguing eventually, the aesthetically and mechanically "good" as well as the ungainly and inefficient. In fact, some so-called "good" postures may be more taxing to the neuromuscular system than some so-called "poor" ones. If such be the case, and residual neuromuscular hypertension results, the "good," erect postures will be deleterious to health as well as the "poor," slumpy ones.

Space does not permit a full description of the various standing postures assumed by our cases during their orthopedic examinations, but the conclusions reached in this particular phase of this study may be of interest.

(1) Many different types of standing postures are represented in a group of unselected cases revealing degrees of marked residual muscular hypertension.

(2) Vigorous physical activity in the growing years seems to be largely responsible for the development of a well formed and flexible skeleton which may be maintained, in later years, without too much extra muscular effort in an erect, well balanced, standing position.

(3) When the skeletal weights are carried out of line, various degrees of static strain are placed on muscles, causing them to become hypertense tonically.

(4) The relationship of skeletal postures to muscular tensions is not always causal. In many instances the postures as well as the residual tensions are caused by other, more fundamental factors, emotional as well as physical.

Nutritional and Metabolic Needs. Since it was impossible to keep our cases under controlled condition as to diet, and since it was impossible to subject them to

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*Residual Neuromuscular Hypertension: Implications for Education, by Josephine L. Rathbone, Ph. D., Published by the author, New York City, 1936.

the numerous laboratory tests which would be essential to a careful metabolic study, it is necessary here to draw on theoretical hypotheses and to suggest other investigations which would supplement the findings of this one. The phases of this subject upon which one should like further information are oxygen utilization, sugar metabolism, liquid intake, ingestion of salts, calcium sufficiency, and the acid-alkaline balance.

Oxygen Utilization. As is well understood, the demand for oxygen comes during the recovery phases, both immediately following mild effort and in the long period necessary for recuperation from severe exertion. The demand for oxygen to the tissues is met by an increase in the pulmonary ventilation, by a doubling of the stroke volume of the heart, by doubling the heart rate, by raising arterial pressure, and by expanding the capillaries.[3]

Pulmonary ventilation, as an important factor in the availability of oxygen, should be given special consideration. It is probably a very important item in connection with hypertonus and easy fatigability. In fact, no one observation about specific muscular tensions was made more frequently during the four years that this study was developing than that the individuals under observation had tense diaphragms and auxiliary muscles of inhalation. In many of our cases it was necessary to increase the flexibility of the chest by encouraging a wider excursion of the diaphragm and a deeper relaxation of all the muscles of breathing.

The relaxation of exhalation often proved more difficult to achieve than the contraction of inhalation because the muscles maintained so much residual tension. Apparently, a tense diaphragm is a common accompaniment of neuromuscular tension anywhere in the body, from whatever cause. When the individual begins to relax, on the other hand, the diaphragm responds by causing a single welcomed sigh or by establishing full rhythmic breathing. The sigh of relief, like that to be observed in manual laborers and robust athletes at the cessation of a bout of effort, is to be encouraged in the training periods in conscious relaxing in order to assure thorough relaxation of the respiratory muscles which have been contracted with the subject's habitual efforts.

There are other physiologic advantages to be gained from unrestricted inhalation and exhalation equally as important as the unimpeded acquisition of oxygen and expulsion of carbon dioxide. In the first place, the diaphragm, resting as it does on the liver, rhythmically massages and pumps that organ every time one breathes. In the second place, the contraction and relaxation of the diaphragm affects the entire venous circulation as well as the portal circulation of the liver. It is only because of the tonus of the muscles of the extremities and their frequent movements, as well as the changes in intrathoracic pressure made possible mainly by the changes in position of the diaphragm, that the blood is forced back to the heart. It would be interesting to discover, in a series of cases with excessive residual tonus, whether or not they have a slight constant oxygen debt caused by their constant neuromuscular tension. It is to be hoped that someone will be able to devise a well controlled experiment to investigate this point. The methods of choice for such a study would probably be a combination of tests for the analysis of expired air,[4] and a blood study after the method of Hastings.[5]

Hastings discovered, in an experiment on dogs, by excessive treadmill exercise and by swimming, that the effects of exercise on the blood were as follows: (1) the resistance of erythrocytes to laking by hypotonic salt solutions was increased; (2) the concentration of chlorines in the corpuscles was diminished; (3) the carbondioxide content of the blood was diminished; (4) the bicarbonate of the plasma was diminished; and (5) the percentage saturation of the hemoglobin with oxygen was increased; although (6) the hydrogen ion concentration of the plasma was not measurably altered.[6] If it could be demonstrated that the patient with excessive neuromuscular hypertension showed any of these symptoms habitually, it would support the hypothesis that neuromuscular hypertension is a form of muscular contraction of like kind and as exhausting as physical labor. Furthermore, it would give some indication of the physiologic and nutritional needs of the body. Unfortunately, there are practically no studies available on animals or humans showing the effect of fatigue upon the various constituents of undernutrition.

Sugar metabolism. A dietary item which appears to have a bearing on neuromuscular conditions is sugar. Hypoglycemia or lowered blood sugar is found associated with so many conditions that it may be ascribed as a causative factor in the production of weakness and easy fatigability, as well as nervousness, and periods of anxiety.[7] Furthermore, as is well known, it is definitely associated with a pathologic condition of the pancreas and liver, resulting in hyperinsulinism, or the overproduction of insulin and its constant liberation in the blood stream, causing stupor, epileptiform seizures, amnesia, and coma. Although there may be no actual danger of the store of sugars in the liver and muscle glycogen being used up in normal muscle exertions,[8] there is a danger of developing hypoglycemia if one refuses to obey the first warnings of lowered blood sugar and drives the body toward exhaustion. One should hesitate to increase sugar intake too markedly, however, considering the warning that prolonged high carbohydrate diet, even in a non-diabetic, stimulates excessive insulin formation with the resulting hypoglycemia.[9]

Dieting should be supervised by a physician or technically trained specialist. Enough of the cases under analysis have shown the manifestations of diabetis mellitis—sensory changes, changes in deep reflexes, disturbance in coordination, nerve changes in the form of neuritis, trophic changes and a variety of mental disturbances[10]—that it would be desirable to secure blood studies and urinalysis of a group of cases like ours.

Liquid intake. A practical hint for well being has always been to drink water after work or physical exertion in order to feel rejuvenated. One wonders whether or not this simple procedure serves a real body need. Perhaps the function of the water is either to assist in the physio-chemical katabolism or to keep the by-products of muscular work in sufficient solution, or both. As is well-known, deprivation of liquid intake or loss of blood, resulting in an inadequate volume in the circulation vessels, causes exhaustion very rapidly.[11] Is it possible that forms of effort demanding tonic contraction of muscles over a long period of time might increase the need for water? Observedly, tensions accompanying emotional states do so.

During emotional states, as well as during strenuous physical exertion, perspiration is increased sufficiently to affect a lowering of fluid in the body. It is a common observation, also, that one is forced to urinate frequently during strenuous mental work or when under emotional strain. It would be interesting to measure the quantity of fluid given off under varying conditions and to determine whether or not the entire excretory system functions more actively during states of neuromuscular

tonus. A recent physiologic explanation for the frequent urinating, at least, has developed out of work under way in the Laboratory of Clinical Neurology at Johns Hopkins under the supervision of O. R. Langworthy, M. D. He has shown that the quantity of fluid in the cat's bladder, which calls forth the voiding reflex, can be increased or decreased by transection of the brain stem at different levels. He concludes "that tone in the musculature of the bladder is controlled by similar mechanisms to those that control tone in the striated musculature. There is evidence that the control of this tonic mechanism is largely a function of the cerebral motor cortex and is effective at the level of the spinal cord.[12]"

It seems altogether feasible to conjecture that in human subjects mental or emotional stimuli which bring about reflex postural patterning of the skeletal muscles may cause, also, reflex tonic contraction of the "smooth" sphincter muscle of the bladder, thus necessitating frequent urinating. Jacobson states quite definitely that "every psychic experience and every mental effort is always accompanied by a contraction of the bladder.[13]"

Salt in the diet. Cannon, reporting work by Adolph, Baird, and Haldane, suggests that the taking of common salt (NaCl) with water will markedly increase the retension of water in the body, since a "shift toward the alkaline reaction causes retention of water by connective tissue," while a "shift toward the acid results in its release.[14]" As a case to demonstrate the desirability of maintaining the fluid content of the body by this expedient, he mentions the experience of a man on a salt free diet, reported by Taylor. "Sweating became prominent, he early lost appetite, on the fifth day he experienced noteworthy lassitude, on the eighth and ninth days he suffered from muscular soreness and stiffness, and then from sleepiness and muscular twitchings.[15]"

"During the World War, astounding reports were circulated regarding the promotion of muscular activity and the prevention of fatigue in both man and animals through the administration of . . . sodium phosphate. . . . They emanated from physiologists of repute. . . . It is by no means absurd to assume that an exceptionally vigorous metabolism of phosphorus in severe muscular work calls for an abundant replacement.[16]"

After reporting investigations by Embden of the University of Frankfurt and Flinn for the United States Public Health Service, the Editors of The Journal of the American Medical Association make the following statements in an effort to explain the benefits of sodium chloride or sodium phosphate in solution, "There is an undeniable feeling of well being experienced by many persons who ingest the salt. It seems highly probable that this depends on its stimulating action on the intestinal tract, and is due in part to increased elimination of alimentary wastes. . . . Perhaps these investigations will serve to emphasize anew that general well being demands proper alimentary functions, even if productive ability is not specifically enhanced thereby.[17]"

Whether the beneficial effects of these salts be in their replacement in the skeletal muscles or in their stimulating effect on intestinal smooth muscle, their use in therapy is suggestive.

Calcium sufficiency. The salts of calcium appear to have a further beneficial effect in cases of neuromuscular hypertension. According to Cannon, besides its utilization for the growth of the skeleton and the teeth, for the repair of broken bone, for the coagulation of the blood, and for the production of serviceable milk, calcium maintains the "proper conditions of responsiveness in nervous and muscular tissue.[18]" If the calcium of the blood becomes lowered, twitchings and convulsive movements follow, which, however, can be quickly relieved by injecting soluble salt of calcium in an amount sufficient to restore the proper percentage in the blood.[19]

Several of the cases analyzed for this study were given calcium in some form, by the physicians in charge, with beneficial results. In at least all cases of localized muscle soreness of long duration, suggesting myocitis, calcium therapy should be instituted.

Sun therapy as a means of assisting calcium metabolism has its place in the treatment of all cases of faulty responsiveness of the nervous and muscular tissues. Is it possible that one reason why many individuals claim to get more irritable and restless in the late winter is because the ultra violet rays of the sun have been reduced for many months and because the calcium metabolism of the body has been reduced accordingly?

Acid-alkaline balance. Another reason for increasing the intake of the salts of sodium, calcium, and potassium—the fixed bases—would be to assist the buffer action of the body fluids to offset an increase in lactic acid due to muscular activity.

In the conclusion of an article describing experimental efforts to influence the acid-base equilibrium by diet and by certain salts, Dennig, Gottschalk and Teuscher state that incomparably greater effects are produced by comparatively small quantities of salts than by any dietetic measure.[20] They claim that an exclusive diet with acid or alkaline excess is capable of producing only the slightest acidosis, or alkalosis in the body. A meal of soy-beans, according to their findings, provokes a stronger alkalosis than the usual alkaline producing diet, rich in fruits and green vegetables. Hence, if the acid-base equilibrium is to be influenced either towards the acid or the alkaline side, it is of hardly any use to change the diet, they say, unless the inexpensive soybean, which favors alkalization to some extent, is used. According to their findings, it is much more simple and efficacious to administer such salts as ammonium chloride and calcium chloride for acidifying effects, and sodium citrate and sodium bicarbonate for alkalizing effects.

Endocrine Involvements. It must be remembered that the endocrine system, composed of some eight or more glands of internal secretion, is a great coordinating or integrating mechanism which exerts most profound influences over the entire body.[21] This system may have as great an effect upon muscle tension as the nervous system. In fact, it may be part of the nervous system or the nervous system part of the endocrine. Certain evidence points in the direction of an eventual reevaluation of the relative functions of the glands of internal secretion and the nerves. While the larger glands of internal secretion may be more closely integrated with the central nervous system than so far acknowledged, the nerve endings themselves may be glands of internal secretion. Even though it is impossible and erroneous at this stage of knowledge on the subject to discuss all nervous phenomena as glandular in character, it is possible to suggest, from physiologic information and from our clinical cases, certain associations between residual muscular hypertension and acknowledged glandular idiosyncrasies.

Although our cases were not studied, each and every one, for glandular idiosyncrasies, in this collection were those referred by physicians with all the types of pathologies suggested in current literature. This fact may indicate that endocrine dysfunction does actually

affect the degree of residual neuromuscular hypertension in the cases where it is recognized; or, since there is no uniformity in the endocrine picture of these cases, that it cannot be considered of real importance in our analysis. We should probably look for more uniform accompaniments of the tension in order to draw any conclusions as to actual causes.

Parathyroid tetany. To return to a discussion of calcium metabolism, certain definite information is available concerning the presence of serum calcium and the functioning of the parathyroid gland in tetany. The individual with a hyper-active parathyroid is known to have low blood calcium and to be inclined toward increased excitability of striped muscle[22] as well as temper tantrums, stuttering, and loss of weight. Furthermore, the individual with insufficient calcium and with parathyroid tetany complains of muscular spasms and cramps as major symptoms.[23] During observations on infants with parathyroid tetany, in addition to the low serum calcium, there were demonstrated abnormal electrical reactions which returned to normal with a rise in the serum calcium.[24]

According to some observers, a very definite subsidence of the symptoms associated with dysfunction of this endocrine gland can be affected by simple dietary therapy, since hyperexcitability, quite like that observed in tetany, is due to lack of calcium alone.[25] According to others, parathyroid tetany itself can be prevented by the administration of calcium lactate, and it can be improved by administration of dessicated thyroid.[26]

It is true, however, that tetany occurs under so many circumstances that it probably cannot be attributed to a single etiological factor. Two hypotheses have been offered: (1) that a lowering of the calcium ion concentration, as indicated above, is the cause of tetany in all cases, and (2) that all forms of tetany are due to an alkaline shift in the acid-base balance.[27] Tetany may be caused by hyperventilation or an overdose of a bicarbonate inducing an alkaline shift in the acid-base balance of the blood without an accompanying decrease in the physiologically available calcium. Such a phenomenon may be explained on the basis that deep breathing decreases the hydrogen ion concentration until sufficient carbon dioxide from muscular effort is available to bring it back to normal, or until an equivalent amount of haemoglobin is ionized to take its place in combination with the available alkali.[28]

Observations of other investigators point toward an explanation of why tetany is not always recognized in cases of calcium deficiency coming under the reading of rickets. Shohl and his co-workers state that, as nearly as they can determine, latent tetany occurs at a time when by x-ray evidence rickets is not progressing but healing—when the serum calcium is increasing. They claim that only when a mild rickets of the healing type is produced does tetany result. They believe that, in rachitic human infants, interrupted or insufficient therapy, such as to evidence partial and incomplete healing, is associated with the development of idio-pathic tetany and claim that tetany is associated with the third phase of rickets. At least two of our cases showed marked signs of rickets in their childhood. When we knew them they were well past an acute stage of rickets, being more than thirty years old. Is it possible, however, that they had never completely recovered their phosphorus-calcium balance? Were they in Shohl's third stage of rickets?

Pituitary involvements. Let it be recalled that the hormones of the pituitary gland, besides determining the ultimate size of an individual, are "linked with such conditions as epilepsy and insanity,[29]" two forms of pathology which are characterized by hyperexcitability of the nervous and muscular systems. Menninger suggests that the pituitary body affects general excitability by controlling sleepiness, fat distribution, sugar utilization and sexual activity.[30]

Several of the cases under analysis had been told by physicians that they had pituitary involvements. They exhibited marked "readiness" during their lessons in relaxation, assisting in any movement suggested by the operator. It was extremely difficult for them to learn to release their tension, in spite of the fact that they learned readily to perceive it accurately. They appeared to have an alertness of the entire body which showed itself mentally as well as physically. They were dynamos of energy and the physicians who referred them to the corrective physical education clinic were truly concerned about the possible consequences if their nervous excitability were not shunted into purposeful channels. These individuals seemed to have dammed up streams of energy.

Unfortunately, from the standpoint of a clear etiological analysis, these cases revealed several possible causes of hypertonus. They had emotional problems as well as actual sources for pain, and a decision could not be reached as to whether these latter factors or the pituitary involvements came first in causing the tension. Doubtless the glandular complications were very important, however, and should not be passed over lightly in these cases. Their trouble had been of too long standing and their tension persisted too definitely after it was possible to gain their full cooperation in psychologic and educational procedures not to indicate that the underlying cause was physiologic, in part at least.

Thyroid involvement. Among the cases were several who had involvements of the thyroid, both hypo and hyper. One had had a thyroidectomy, and two had an acknowledged thyroid deficiency for which they were being given thyroid medication at the suggestion of physicians. These cases all were in the vague classification known as "run down condition." They had indefinite symptoms of easy fatigability and complained of feeling depressed and stupid, of perspiring little, and of feeling cold much of the time. Yet they had very definite residual neuromuscular hypertonus.

Those who had been diagnosed by physicians as hyperthyroid in tendency showed the customary signs of a mild hyperthyroidism—"poppy eyes," loss of weight, and warm and moist hands[31], and revealed other characteristics which may be linked with overfunctioning of the thyroid—hypertonus of the smooth muscles: in some cases, the uterus; and in others, the intestines.

From the usual understanding of thyroid involvements it would seem more logical to anticipate increase in tonus of all muscles with increase in the glandular secretion and decrease in tonus with decrease in the glandular function. The fact that our records revealed hypertonus cases in both categories suggests that thyroid functioning is not in itself responsible for muscular hypertension, and that other factors must be held primarily responsible.

Gonadal functioning. In respect to the functioning of the gonads in the cases under analysis nothing definite is known. Since initial psychoneurotic disturbances frequently appear at puberty and occur in relationship to menstruation and pregnancy[32], and since a marked rise in blood pressure frequently occurs at puberty and the menopause[33], it is logical to conjecture that gonadal activity does affect the functioning of the muscular and nervous systems. Since, however, "it is now also known

that the pituitary, the thyroid, and the adrenal glands may modify gonad activity,[34]" one cannot be too dogmatic about assigning to the sex hormones themselves responsibility for bodily reactions.

Activity of the suprarenal glands and the thymus. As to evidence concerning the relationship of the suprarenal glands and the thymus to residual neuromuscular activity, this dissertation has little to contribute. In considering our cases with residual neuromuscular hypertension, however, it is interesting to recall the early experiments of Cannon on the function of the adrenals.[35] As is well known now, their sympathetic stimulation under emotion and stress, followed by the secretion of adrenin, favors muscular activity by releasing bound sugar from the liver, by accelerating the heart, and increasing the blood pressure.

It is important to inject at this point some comments by Aldrich, who says that overactivity of the vagus nerve accounts for spasm of the smooth muscles under vagus control, resulting in "stridor, dyspnea, cyanosis, choking attacks, asthma, pylorospasm, and enterospasm, laryngospasm, spasmodic cough, irregular breathing and even sudden death" in cases diagnosed as thymic hypertrophy.[36] He claims that vagatonic symptoms may be produced theoretically either by stimulation of the vagus or parasympathetic nerves, or by reduction in activity of the sympathetic nerves with the associated reduced suprarenal activity.

As will be described later, many of our cases did actually present the symptoms listed above; and it is to be surmised that they were caused by nervous system phenomena instead of thymus dysfunction, since the individuals studied were many years past the age when the thymus is supposed to atrophy. A discussion of the symptoms suggested above leads to a consideration of disturbances of the internal organs.

Before leaving the subject of endocrine imbalance and its affect upon muscular and nervous reactions, it is necessary to emphasize again that when emotional reactions are intense enough one is quite willing to believe that internal secretions are modified to support the muscular activity, although accurate evidence is lacking. What Notkin states in regard to psychoses suggests a sound attitude to be adopted in regard to all neuromuscular symptoms. He says, "the relationship of the endocrine dysfunction to mental disorders has been overrated considerably, especially if we bear in mind the frequent occurrences of endocrine dysfunction without psychoses.[37]" Of course, he does not deny the possible occurrence of some changes, often non-demonstrable, in the metabolism of psychotic individuals or even in people with personality deviations; but he warns that it is hazardous, at least for the time being, to accept as an etiological factor something concerning which next to nothing is actually known.[38]

Summary of influences on neuromuscular hypertonus of nutritional and endocrine factors. There is no doubt that the physiologic factors discussed above have an important bearing on physical well-being and freedom from excessive neuromuscular tension. It is to be regretted that certain aspects of the problem could not be directly studied in the subjects used for this investigation; and it is to be hoped that explanatory experiments on human material will be forthcoming from physiology laboratories. Questions raised by our data are as follows:

(1) If the availability of oxygen is important for the recuperation phase of all muscular effort, how can respiration and circulation be increased judiciously in cases exhibiting residual neuromuscular hypertension?

(2) What diets would prove beneficial in cases like the ones in our data?

(3) What effect may result from a shortage of water in the body, and how may its retention in the tissues be facilitated?

(4) Does hydrogen ion concentration of the body fluids actually increase sufficiently during physical and mental work and disturbing emotional states to upset the acid-alkaline balance? If so, how can the buffering action be improved?

(5) If failures in the functioning of the parathyroid glands increase neuromuscular tonus, what measures may be used to stimulate it?

(6) What are the actual effects on the skeletal and smooth muscle of various endocrine disturbances? How can these disturbances be rectified by medication and physical therapy?

(To Be Concluded)

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(Editor's Note: This is the first part of a fourth article in the series by Miss Rathbone. The second part will appear in the next issue.)

The Michigan Program for Crippled Children

Harry H. Howett, A.M.

Historical Background

As early as 1881 the Michigan Legislature enacted a law which laid the foundation for the present State program for the care, treatment and education of crippled children. It provided for "dependent persons . . . medical and surgical treatment, or either, together with board, lodging, nursing and other proper care, free of charge," at the State University Hospital.

The General Assembly of 1897 extended this State policy to apply specifically to children by requiring all physicians to report to the proper local authorities, those who at birth "shall be afflicted with any deformity or malady that may be cured by a surgical operation." Such authorities were empowered to transport children, with an attendant, to the University Hospital in order to receive treatment at State expense. While this statute was not wholly a crippled children's law, it included crippled along with all types of afflicted children. It has often been said that the first crippled children's law was passed by the legislature of Minnesota in this same year.

Ten years later power was given Michigan Probate Courts, "when the health or condition of the child shall require it," to place such child "in a public hospital or in an institution for special care or treatment" at county expense. The principle of this act was again emphasized in Act No. 137 in 1921. The latter statute authorized the same courts to refer children to any "institution or hospital" with which the county board of supervisors may have contracted for service of this kind to be paid from the general county fund. These Acts calling for payment by counties were seldom used for the care of crippled children.

The first act in Michigan pertaining wholly to crippled children was passed by the legislature of 1913. Including amendments made in 1915, it provided that indigent crippled children could be admitted to the State Public School for Dependent Children if capable of "acquiring a common school education." This program included primarily custody and education and largely neglected the medical and surgical needs of the children. The act was repealed after fourteen years, leaving the State with no program for crippled children needing custodial care.

A second act of 1913, which seems to have been patterned after the Minnesota law of 1897, provided "free treatment at State expense for deformed or afflicted" children at the State University Hospital when assigned there by order of the Probate Court. The portions of this statute relating to the hospitalization of crippled children were supposed to have been repealed in 1927, but a clear cut distinction between "afflicted" and "crippled" children was not legally made until in 1933. This act, including all the amendments made in 1933, 1935 and 1937, is still designated "Act No. 274 of the Public Acts of 1913" and generally called now "The Afflicted Children's Act." In 1915 a very similar law was passed dealing with the treatment of adults but at county expense. This is usually referred to as the "Adult Afflicted Act."

Executive Secretary, Michigan Crippled Children Commission, 458 Hollister Building, Lansing, Michigan.

Michigan Society for Crippled Children

In 1919 Reverend Lloyd Douglas, then pastor of the First Congregational Church in Ann Arbor, appealed to the Conference of District No. 18 Rotary International for assistance in enlarging the program for crippled children then being carried on at the State University Hospital in a voluntary way by some of his parishioners, the Ann Arbor Rotary Club, and other local organizations, including the King's Daughters. The response to his appeal was a committee appointed by the officials of the Rotary District to undertake a state-wide work. This committee, headed by the District Governor, now the Chairman of the Michigan Crippled Children Commission, engaged a field director to work with the University Hospital. Miss Alberta Chase, R.N., was chosen and began work early in the year 1920. In 1921, following the efforts and accomplishments of this committee, and conferences with the Ohio Society for Crippled Children, the Rotarians of Michigan established the Michigan Society for Crippled Children. It enlisted the cooperation of Rotarians and non-Rotarians, men and women, until in 1923 the membership had secured sufficient information and was influential enough to successfully request of the legislature a new act relating to crippled children. Some time later, through the efforts of Miss Chase, there were thirty-three county chapters affiliated with the Society. In 1927, also as a result of the activities of the Society, the act creating the Michigan Crippled Children Commission was passed by the legislature.

During the calendar years 1922 to 1927, inclusive, the Society held orthopedic clinics throughout the State. Expert examinations were given to 5050 crippled children in 61 different clinics.

At each succeeding session of the legislature, the Society has sponsored the program it created in Michigan for the care and education of crippled children. This report will show the wisdom of the founders of the Society and the great need for this humanitarian service in this State.

Later Legislation

Before the repeal of the provision for the education of crippled children at the State Public School, however, the legislature of 1923 provided for their education in special classes in public schools, wherever established by local boards of education, with the approval of the State Superintendent of Public Instruction. This educational program, however, reaches only a portion of the crippled children in rural sections and makes no provision for those needing custodial care with accompanying educational advantages. Herein lies the chief obstacle to the completeness of Michigan's State Program for Cripples.

The last in the series of enactments which established Michigan's State Program for crippled children

provided for a permanent State commission. This statute, as amended, declares a "policy" for Michigan in regard to such children, and arranges a plan of coordination relating to all services rendered to crippled children by both public and private interested agencies through the Michigan Crippled Children Commission. Without this policy and plan, the sum of the parts of Michigan's services to the crippled did not equal a whole program.

Michigan Crippled Children Commission

The Michigan Crippled Children Commission was created by the legislature of 1927 upon the request of the Michigan Society for Crippled Children. It held its first meeting in the Capitol on July 18, 1927. It opened its office at the State University Hospital on November 1, 1927. The office was moved to the Capital of the State on October 4, 1928.

Duties of the Commission

Under Act No. 236 of 1927, as amended, and now superseded by Act No. 158 of 1937, the Commission has the following duties:

(1) To locate and enumerate crippled children through the services and cooperation of local medical, health and welfare authorities and the annual school census enumerators under the supervision of the State Superintendent of Public Instruction.

(2) To organize and conduct free public diagnostic orthopedic clinics throughout the State.

(3) To cooperate with Probate Courts, orthopedic centers, convalescent homes and hospitals designated in the Act, or approved by the Commission, in securing high grade hospital services and efficient medical and surgical treatment for committed patients, as defined by the Act.

(4) To transfer children from one hospital to another without referring the matter back to the Court of original jurisdiction.

(5) To receive from such hospitals reports necessary in initiating a proper out-patient or follow-up service through paid and volunteer agents.

(6) To provide or approve hospital schools for crippled children, and to assist in financing them when they meet the prescribed requirements of the State Superintendent of Public Instruction.

(7) To cooperate with the Federal Children's Bureau in carrying out the provisions of Title V, Part II of the Social Security Act.

(8) To provide care and education for eligible crippled children needing custodial care.

(9) To make rules and regulations, when necessary, to carry out the intent, purpose and "policy" of the Act, and

(10) To prepare a biennial report to be submitted to the Governor, State Administrative Board, and the members of the legislature.

Ten Years of Experience

During the ten years the Commission has operated, it has registered approximately 25,000 crippled children. It has not yet reached the stage where the discharges equal the intake annually. The live file for the past five years has stood respectively at 10,274; 11,055; 11,800; 13,241 and 13,746. New cases registered annually average about 2,500.

In the fiscal year 1931-32, 1,863 different individuals were hospitalized, and in 1935-36, 5,410, or an average for the five years of approximately 4,025, at an average annual cost to the State of $650,000.

The Commission has approved four hospital schools at which about 2,500 convalescent crippled children receive training at an annual cost to the State of about $20,000.

Under the provisions of the new Crippled Children's Act, the Commission is required to approve hospitals and hospital schools from among hospitals which have already been placed on the accredited list of the American College of Surgeons, and which must "maintain orthopedic equipment and convalescent and educational facilities, including qualified instructional services and attending orthopedic surgeons and other specialists approved by the Commission." Among the specialists there must be on the staff of the hospital a physical therapist who is a member of the American Physiotherapy Association, or the National Congress of Physical Therapists. Physicians and surgeons must be members of national or state medical associations relating to their specialists and confine their practice to such specialities.

The follow-up service to State patients is carried on through a cooperative program supervised by the orthopedic field nurses on the staff of the Commission. Hospitals in the larger centers maintain social service departments which conduct the follow-up services in their respective immediate communities. Children coming to orthopedic hospitals from outlying districts are followed up by county and school health nurses, and in a few counties, by physical therapists or nurses or social workers employed by local service groups or county branches of the Michigan Society for Crippled Children. The orthopedic nurses on the staff of the Commission have the State districted and each one is responsible for the supervision and checking of the follow-up program established in each county of her district.

Physical therapy treatments are given at all approved hospitals, convalescent homes, and orthopedic centers under the direction of the orthopedic surgeon in charge at the various institutions. The cost of physical therapy treatments to State patients while in the acute stage of treatment is paid for by the hospital and included in a flat rate per diem charge to the State, but in the convalescent stage these treatments are paid for by the State according to an established fee schedule.

Administration of Orthopedic Day Schools

We have already referred to the act of the legislature of 1923 which created the State program of Special Education. This Act has been under the supervision of the State Department of Education and is operated in conjunction with the Division of Vocational Rehabilitation. The scope of the department covers classes in the public schools for crippled, deaf, blind and epileptic children. Pupils are admitted in special classes only when they can not be educated safely and profitably in the regular grades. Children in the orthopedic classes are admitted and discharged from the classes on the recommendation of an orthopedic surgeon.

Teachers to be employed in special classes must meet the requirements set by the State Superintendent of Public Instruction for the teachers in the regular schools of the State and must have had at least one year of special training in the particular field of special education in which they are to engage. The State requires that a competent orthopedist examine each child and make recommendations in writing certifying that he or she requires special service or special equipment, and because of the handicap, cannot profitably or safely be educated in regular grades. The Department recommends two such examinations during each school year. Where the number of pupils justify it, this medical exam-

ination may take the form of a clinic held under the supervision of the Board of Education at the school, or special groups of children may be transported to a hospital clinic.

Each orthopedic day school must have the services of a physical therapist who must be a graduate of an approved school of physical therapy with pre-requisite of physical education or graduate nurse background.

All necessary physical therapy treatments given in the school are given under the direction of the orthopedic surgeon to whom the child has been assigned for examination, and the school must be equipped to give heliotherapy, hydrotherapy, massage, etc.

Transportation is furnished to those attending orthopedic classes and the Board of Education may purchase its own bus, engage its own drivers and attendants, or it may contract for taxi service. It is the general policy throughout the State to pay a special teacher $100 per year more than is paid for an equivalent service in the regular grades. Coming within the interpretation of the Act, the practice has been established to allow use of the State reimbursement for the actual cost of materials in furnishing lunches as a part of the necessary special service to physically handicapped children.

The law requires that the State Department of Education shall reimburse local boards of education for the actual expense incurred for teachers' salaries, for the purchase of the necessary special school equipment, and for any other services required for such schools or classes, but the total amount per pupil paid to any one school district shall not exceed the difference between per capita cost of instruction and equipment for crippled children and for normal children in the first nine grades of said school district. In no case shall the amount paid exceed $200 for each child instructed in the said school district during the school year, and this pro rata is maintained for those pupils who attend less than a school year.

During 1935-36, there were special classes for crippled children in 27 cities and in five of them there were classes enough to maintain a special school. Enrollment for that year was 2,208 pupils who were taught by 106 teachers and treated by 33 physical therapists.

ESTIMATE OF CURRENT SERVICES

Since the advent of the State-Federal service to crippled children in February 1936, a quarterly report of services rendered to crippled children has been prepared for the Federal Children's Bureau. The Commission has been designated as the agency in the State "to administer a program of services for children who are crippled or who are suffering from conditions which lead to crippling, and to supervise the administration of those services included in the program which are not administered directly by it." Therefore, the quarterly reports include information in regard to services rendered through the orthopedic day schools and through other agencies not directly connected with the program administered by the Commission. Up to the present time no accurate or complete report has been possible but each quarterly report has been more comprehensive than the preceding one and encouraging progress is being made as the work proceeds.

During the quarter ending June 30, 1937, 22 hospitals gave 5631 clinic services to 2097 crippled children. Unfortunately the State University Hospital was unable to give a report on this service and therefore it may not represent more than fifty per cent of all such services rendered in the State during that period.

In the same quarter, the 23 approved hospitals gave 23,900 days' hospital care to 525 children. Of this number 11,905 days were given at the State University Hospital, showing about 50 per cent of the service rendered at all the hospitals.

The report concerning convalescent care given is still inadequate and unsatisfactory because the State and local public hospitals were unable to give any accurate statistics. However, the private hospitals accepting State patients rendered 21,643 days' service to 245 individuals. Eight children received 980 days' care in foster homes.

In follow-up services, the report shows the service given to 2528 crippled children to be distributed as follows:

Individual services by public health nurses	1,924
Individual services by medical social workers	16,189
Individual services by other social workers	80
Individual services by child guidance and psychiatric workers	1,195
Individual services by physical therapists	4,022
Total	23,410

To this total of follow-up services at the approved hospitals is to be added the individual calls of the supervisory nurses on the field staff of the Commission, which totaled in the quarter 3494; and the 3556 services rendered to 843 crippled children by public health nurses which were reported through the State Department of Health. This makes a grand total in three months of 30,460 services.

Eighteen out of twenty-six orthopedic day schools reported 997 clinical services to 571 individuals and 24,922 physical therapeutic services to 618 crippled children.

The total physical therapy services in schools, hospitals and convalescent homes, exclusive of the State University Hospital, numbered 28,944, which were given during the quarter to an unrecorded number of crippled children estimated at about 900.

Summing up, we find 46,523 days of hospital treatment were given and in addition, 62,010 other services were rendered to an indefinite number of crippled children. There is no plan yet devised whereby a record of various services for an individual may be recorded so as to eliminate duplication in the report.

CONCLUSION

The Michigan program has developed from a State centralized plan in 1927 to one which is now largely decentralized. As decentralization has progressed, the problem of keeping accurate measurement of the services rendered has continually become more complex. It is the hope of the Commission that through the reports now required by the Federal Government the statistical information may continuously become more accurate, the services rendered be placed each quarter on a higher quality basis, and that a larger percentage of crippled children may be reached with approved services each year. An attempt is being made also to make a study of end-results. Possibly the Federal Government in time may be able to make a comparative study of end-results in a centralized and a decentralized type of state program. It is the feeling of the Commission that Michigan can make a favorable showing in any such comparative study which may be consummated.

Calcium in Health and Disease

Adele M. Towbin

The purpose of this paper is to present some vital aspects of the mineral salt calcium, its relation to health of the body and to some manifestations of disease (mainly malnutrition and certain other bone involvements).

The problem of mineral content and balance in the human body is one which has been of great concern to physiologists and chemists for the past 45 years. As a result of many years' work of experimentation, it has been definitely established that minerals are very important factors in the prevention and cure of disease and physical abnormalities.

Evil effects in the body were previously regarded as due to a deficiency of vitamins, but recent works show that these effects may be attributed to a lack of correspondence between the mineral content of the diet and the mineral requirement of the body. The experiments of Jacques Loeb during early parts of this century show that if the normal functioning of various organs is to be maintained, minerals must be present in the tissues and fluids in very definite proportions to form a physiologically balanced solution.[1]

Two such balanced solutions are sea water and blood. In the blood of animals and humans, the need for the maintenance of the proper balance is very great. The first condition is the maintenance of the balance of minerals so that the fluid is kept practically neutral in reaction. A balance of minerals taken in is of vital importance for the other components of the body—bones, teeth, fluids and cell tissues.

Various mechanisms in the body are concerned in preserving the physiological balance and normally are efficient in doing so, in spite of the irregular supply presented in foods.

When the deficiencies or excesses in the diet are greater than these regulating mechanisms can deal with, the resulting disordered functions of the cells make themselves manifest as disease.

All minerals are continually being lost from the body in excretions, as well, and since all are required as constructive material in growth, mineral content in correct proportions is to be desired.

Calcium Requirements

When the output of Ca equals the intake of Ca, the organism is considered to be in "calcium equilibrium." This is usually true for the adult who makes daily use of the mineral in his bodily processes but does not increase his store of them. In the growing young there is usually less of the mineral excreted than is taken in. (In the process of bone or teeth development, Ca is absorbed and used.) This condition is known as a "positive Ca balance." If, however, the amount of Ca eliminated is known to be more than is taken in, the bodily store of the mineral (probably from the bones, teeth or even blood serum supply) is being depleted; the body is then in "negative Ca balance."

Sherman reports that the average daily American diet has about .45 gm. of Ca which under ordinary circumstances is not sufficient for the maintenance of "Ca equilibrium."

The amount necessary is about 1 gm.[2] Since, also, the assimilation of Ca depends on protein intake among other factors, he suggests the adult's diet should provide for 1 gm. Ca for every 100 gms. of protein. The low intake in the American dietary is ascribed to the low content of milk and dairy products. It is interesting to note in this connection that the dietary of the Finns has from 2 to 6 gms. of Ca oxide daily, due to the large milk consumption.[3]

The breast-fed infant requires daily from 13 to 17 gms. Ca oxide, according to Orgler. In this instance, it is necessary to keep in mind the difference that exists between absorption and assimilation of human and cow's milk. While about 70 per cent of the Ca content of human milk is retained, only 30 per cent of cow's milk is utilized. And since a growing child stores about .3 gm. Ca daily, a larger supply should be given.[4] The intake should be increased also in the period of pregnancy, and lactation, as well, for where the need of Ca by the fetus is increased, the mother's supply may be taxed. La Mer states that the Ca requirement of growing children is twice that of adults, while that of nursing and pregnant mothers is three times the amount.[5]

An analysis of the body Ca composition was made by Bogert and Hastings who state that a person weighing 70 kilograms has 1.5 per cent or 1,050 gms. Ca (and 1 per cent or 660 gms. phosphorus). Of the total amount, 99 per cent is localized in the bones and teeth. The form that it takes is tricalcium phosphate (85 per cent); the skeleton is mainly Ca carbonate. The remaining 1 per cent is in other salts and fluids.[6]

Calcium Absorption

A vast amount of research has been done on absorption of Ca from the intestinal tract. Many workers have denied that Ca is stored in tissue or even absorbed. This was maintained to be true in the level of blood Ca, even when large amounts of mineral salts were given orally to animals.

Meigs, Blatherwick and Corey observed only a slight increase in plasma Ca in cattle; Denis and Corley found no elevation of serum Ca in rabbits and no retention in tissue.[7] Halverson, Mohler and Bergeim, and Clark reported no increase in serum Ca in animals given a Ca rich diet or Ca with food.[8]

On human subjects, the experiments of Denis and Minot show no elevation of blood Ca by daily ingestion of 6 gms. of Ca lactate for a period of 10 days. This result was confirmed by Kahn and Roe.[9] The latter investigators maintain, however, that in the above works the relation of blood Ca concentration to the time of ingestion was not considered, and this fact may account for the failure to find any change in the blood Ca concentration.

Positive evidence of absorption was submitted by Hjort. In work on dogs, he found that the normal blood Ca was raised when the Ca salts were given orally. His

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analyses differed from the others in that he examined the blood hourly, or at two-hour intervals. (The above workers with the exception of Kahn and Roe usually made their analyses twenty-four hours or several days after the last Ca ingestion.)[10] The increase in serum Ca was obtained when the Ca salts were given in proportion of .2727 gms. or more per kilogram of body weight. Ca lactate caused an elevation of 48 per cent, Ca chloride 32 per cent, Ca glycerophosphate 8 per cent and Ca carbonate 7 per cent.[11]

Elevations in serum Ca of 40 to 214 per cent were obtained by Irving, working on dogs with intraduodenal introductions of Ca chloride and Ca lactate.

Interesting data is submitted by Kahn and Roe on the problem of Ca absorption from the intestinal tract in human subjects. This problem is of value since it pertains to therapeutic uses through oral administration of Ca. It may also throw light on various hyperesthesias and hypersusceptibilities to injection and oral administration.

In the opinion of Cantarow, "The work of Kahn and Roe appears to have conclusively settled the question of absorption of Ca salts from the normal intestine."[12]

Their control experiments consisted of giving 20 gms. of Ca lactate orally in about 300 c.c. of water to three subjects.[13] Samples of blood were drawn hourly for 7 hours to make estimations. Their results are tabulated in the following:

Grams Administered	Maximum Elevation of Ca level	Shown at	Returned to Normal in
20	81%	4-5 hrs. later	10 hrs.
5	80%	6-7 hrs. later	14 hrs.
2	49%	6 hrs. later	8 hrs.

Thus the hourly average curve for the three subjects shows a maximum elevation of 81 per cent between the 4th and 5th hours after ingestion, and returns to normal by the 10th hour. With a 5 gms. dose, average results of a maximum elevation of 80 per cent above the normal between the 6th and 7th hours were obtained. The level remained elevated for a longer period in this case; it returned to normal approximately 14 hours after ingestion. With a dose of 2 gms. the 6th hour after ingestion, the maximum elevation was 49 per cent and became normal 8 hours after ingestion.

Their conclusions were that "Ca is absorbed from the intestine just like any other diffusible substance. The rise in the concentration following the ingestion of Ca salts varies according to the size of the dose, but is not strictly proportional to the dose taken." The first appearance of Ca in the blood is favored by large dosage, but the return to normal is not proportional to the dosage. This point is important therapeutically.[14]

Furthermore, Kahn and Roe explain the rapid return of the concentration to normal in the case of the ingestion of 20 gms. as probably being due to an increased irritability of the intestinal mucosa by the larger amount. Also optional absorption is determined by two opposing factors—mass action of the dose and possibly irritant action of the salt; it is a resultant of the two opposing influences. The optional therapeutic dose would appear then to be 5 gms. of Ca lactate, as shown by their results. Below this amount there is insufficient mass action; above this quantity some unknown influence (possibly irritation of the intestinal mucosa) depresses absorption.[15]

The law of mass action is also referred to by Aulde (1928) when he condemns certain uses of Ca medication conducted on a mechanical basis rather than in conformity to physiological chemistry.[16] Chemical inter-relationships (law of mass action) are not respected in this connection.

La Mer (1932) also claims that certain inorganic salts of Ca (and P) can function as well as organic forms in meeting deficiencies of these elements.[17] In addition, as a basis, he refers back to the early work of McCollum (1907) and late works of Steenbock, Hart, Sell and Jones.[18]

Ca-P Relationship

Sufficient evidence exists to show there is a mutual influence between Ca and P—they are reciprocally related.[19] Aulde (1928) remarks about the complementary association of Ca and P and says they act in combination as well as separately. With an unsuitable dietary, a loss of P will result as well as lime depletion.[20] In an experiment with a cracker diet, the daily loss of lime incident to intestinal indigestion was 17.87 grains, loss of P was 11.51 grains, while loss of Mg was but 2.16 grains (the relationship to Mg will be referred to later).

Greenwald states that since practically all of the Ca in the body is present as Ca phosphate, obviously any disturbance in the Ca metabolism must affect the phosphate, but there may be changes in the latter that have no direct relation to the former mineral.[19] Historically, a part of the belief that an increase in P results in a reduction of Ca, and vice versa, is predicated in the observations of Bunge (late 19th century) that injections of large amounts of neutral or alkaline P reduced the serum Ca (the reduction resulted in tetanic symptoms).[20]

Ca and P are related as regards their functions in growth. La Mer observes that liberal amounts of both minerals are necessary in the diet to insure adequate growth and rate of calcification of the body.[21] Citing the work of Bauer, Aub and Albright (1929), he maintains that the skeleton acts as a reservoir for Ca and P.[22] He claims that available evidence suggests that addition to the normal diet of either element alone is undesirable. Though the optimum Ca:P ratio has not yet been established (1932), it probably lies between 1:1 and 2:1.[23] Sherman notes that Blunt and Cowan puts the ratio at 1 gm. Ca: 1 gm P.

Further, La Mer goes on to say that calcification and decalcification are dependent upon the activity of Ca and P ions of the medium, through the solubility product principle.[24] In another place it is mentioned that low Ca rickets which is often accompanied by tetany (the symptoms are convulsions) can be cured by appropriate salts of Ca or P, or both.[25]

Additional data is presented by Howland on the relation of P to growth. He observed that the infant level of P content of the serum is higher than that of adults. At 19 or 20 years of age, the concentration falls to a much lower line.[26] (It is at this age that most epiphyses unite and active bone formation ceases.)

Ca-Mg Relationship

"Ca is very closely related both chemically and physiologically to Mg. Both elements belong to the alkaline earth group; a disturbance of either in the animal body leads to tetany. Both are the principal cations present in bone, and an antagonism is said to exist between them in their effects on the venous, osseous and excretory systems."[27] "The calcium content of the blood serum is ordinarily quite constant, that of Mg and inor-

ganic P much less so. The factors which determine the levels of Ca as well as that of inorganic P and Mg are still imperfectly understood."[28]

While a great deal of work was done in the early part of the century on the antagonism existing between effects of Ca, Na and K (Ringer, Locke, Howell and pupils, and Jacques Loeb), Meltzer and Auer (1908) discovered a most interesting waking action of Ca salts on Mg anesthesia. From a series of experiments on rabbits, they conclude that intravenous infusion of Ca salts is capable of completely counteracting the pronounced inhibitory effects brought on by Mg salts. Conditions of respiratory paralysis, lost lid reflex, motor paralysis, the lost general reflexes, general anesthesia, loss of consciousness, and the inhibitory depression and lowering of blood pressure were amenable to the injections. Where doses of Mg were very large, the counteracting effect of Ca did not hold true.[29]

As pointed out by Aulde in intestinal indigestion, noted under Ca-P Relationship, there was a depletion of the organic constituents Ca and P out of proportion to the Mg depletion. This is assumed to be due to acid excess (diminished alkalinity of the blood) for which a chemic deviation is responsible. It is Aulde's belief that many irregularities of the body's systems are a result of diminished alkalinity of the blood, together with a highly acid urine, all of which have led to Ca depletion with the substitution of Mg.[30] For instance, the "magnesia heart" and the "magnesia kidney" are conditions resulting from the effects of Mg infiltration on the heart and kidney mechanisms, respectively. The process is explained thus: in cases of acidity, Ca or lime, being a stronger base than Mg, combines with acid, Mg taking its place. Thus the Ca is used up and the substitution or infiltration means the impairment and destruction of the tissues in both animal and plant life.[31]

In this connection, Aulde recommends careful choice of foods, using but little of those which have an excess of Mg. In some cases they may predispose the individual to indigestion, or Mg oxide may combine with colloids of the nerve structures and "impede, hinder or destroy their capacity for the uninterrupted transmission of impulses."[32]

Some Ca-Mg. proportions in common foods:

	Mineral	
Food	Ca	Mg
Eggs	7	1
Milk	9.5	1
Cheese	25.3	1
Oatmeal	1	3
Cornmeal	1	15
Honey	1	6

"Another strong proponent of the function of Mg as a regulator of Ca metabolism is Beckâ. In his estimation, Mg regulates the biological relations of Ca in absorption and also the excretion of the organism. He concludes that a Mg:Ca ratio of 1:10 is required for function."[33]

Ca-Vitamin D Relationship

One of the most interesting of the mineral relationships is that of Ca to the vitamin D. The degree to which Ca is potent is dependent upon that vitamin. Called the "calcifying factor" as well as the "anti-rachitic factor," vitamin D is very essential to normal Ca metabolism. This has been demonstrated conclusively by many workers, notably Mellanby (1918), McCollum, Steenbock, Hess and Weinstock. It is held necessary in "fixing" the Ca in the bones and the teeth. Lack of vitamin D will result in a disordered deposit of the mineral and will manifest itself in such conditions as rickets, bow legs, general malnutrition and carious teeth.

The presence of vitamin D results in increased retention of Ca, even by non-rachitics (Daniels and Steenbock).[34] Whether this is brought about by increased absorption of Ca from the intestine or by some effect on the intermediary metabolism has not been conclusively determined.[35]

The work of Bergeim points out that a rachitic condition is due not to failure to absorb Ca but to its defective utilization, which is dependent upon the low phosphate concentration of the blood.[36] "The anti-rachitic substance may act to elevate the blood phosphate by promoting the breakdown of the organic tissue phosphates, thus leading to an increased deposit of Ca, with lessened excretion into the intestine; and consequently better absorption of phosphate therefrom."

As was mentioned by La Mer, low Ca rickets will benefit by appropriate salts of Ca or P, or both, and in addition by ultraviolet radiation or vitamin D in the form of cod liver oil or irradiated ergosterol. The subject of the effectiveness of ultraviolet radiation is very adequately discussed by Dr. Gamgee in her book, "Artificial Light Treatment of Children in Rickets, Anemia and Malnutrition." Practically all the rachitic children in not-too-far-gone stages recovered under the artificial light. It was Huldchinsky in 1919, however, who first introduced the irradiation cure for rachitics by exposure to the ultraviolet of the mercury vapor lamp.[37] He also found that irradiation plus cod liver oil had a much better effect than either alone. Ultraviolet anti-rachitic potency differs with different seasons and hours of the day.[38] In 1921, the curative effect of sunshine was observed by Hess and Unger, and later Hess and Weinstock, Steenbock and Nelson found that by subjecting inert foods to u'tra-violet radiation, or sun, anti-rachitic properties could be obtained.[39]

In the skin, the ergosterol (the chemical precursor of vitamin D) is supposed to be activated by the rays of the sun and become vitamin D, and this makes the blood potent to use Ca. The research of Windhaus proved this.[40]

The negative Ca and P balance that was evident in children with rickets was improved to a positive balance by radiation treatment and irradiated milk (Orr and coworkers).[41]

Mrs. Mellanby after observing the teeth of some 1400 dogs concludes that on diets deficient in the calcifying vitamin, the internal structure of the teeth always deviates from the normal, the degree of deviation depending upon the amount of vitamin D it contains.[42] In addition, experiments with children and adults led her also to conclude that the presence of vitamin D in the diet is essential not only for the original development of the tooth but for its protection later in life as well.[43]

There is comparatively little vitamin D distributed in foods. Therefore, it is essential if it is not available to obtain some form of radiation. Natural foods containing the potent vitamin are egg yolk (with the highest amount), cod liver oil and other fish oils. Small quantities are found in green vegetables and milk.

La Mer cites an important point when he notes that although vitamin D, or irradiation, is involved in the intermediary metabolism of Ca and P, it cannot serve as a substitute for Ca or P.[44]

In cases of hypervitaminosis or excessive dosage of the anti-rachitic factor, hypercalcemia and hyperphosphatemia are discovered. The serum Ca may rise to 15 to 20 mg. per 100 c. c. blood, the phosphorus from 10 to

12 mg. The increased elimination of Ca is chiefly from the urine.[46]

The work of Higgins, Shear, Hess, Morgan and Garrison shows that the anti-rachitic response could not be obtained in absence of parathyroid hormone, and vice versa.[46]

Ca—Parathyroid Relationships

That the Ca and P levels are strongly influenced by the parathyroid hormone has been confirmed by many workers. The administration of parathyroid extract has resulted in increased elimination of Ca. Two of the investigators, Greenwald and Gross, found diminished elimination of Ca after parathyroidectomy. Where no Ca was supplied in the diet, the excess may have been taken from the bones.[47]

The condition of hypocalcemia (decreased Ca in blood) and the subsequent development of tetany (related to the diminution in serum Ca) and diminished urinary secretion of Ca has been found repeatedly by MacCallum and Voegtlin after parathyroidectomy. The effect on P is hyperphosphatemia but diminished urinary secretion.[48]

In the other extreme, hyperparathyroidism, the appearance of hypercalcemia, increased urinary Ca, hypophosphatemia and increased urinary P are noted.[49]

Adding to the belief of Bauer, Aub and Albright (mentioned under Ca-P Relationship) Cantarow says that "it has been demonstrated that the trabecular portion of the bone is the storehouse of available Ca, the shafts being drawn upon later and the increase in the circulating and excreted Ca is derived from these sources in the absence of adequate supply, attending the introduction of an excess of parathyroid hormone."[50]

Functions of Calcium

The physiological value of Ca is unquestionably very great. It is the most abundant metallic element in the body and predominates in the bones. The plasma of the blood has the next highest amount, with cells and fluids having lesser amounts of it. (It is found also in loose combination with proteids.)

Ca salts are essential to growth and bone formation. There is a great deal of evidence that normal calcification depends to a large degree upon the saturation state of Ca salts in the blood. The compound of Ca which is deposited in normal ossification is noted to be $CaH\ Po_4$ rather than $Ca_3(Po_4)2$, by Shear and Kramer.[51] As yet, however, no theory of normal ossification has been satisfactorily accepted by all workers. The solving of the problem, according to Cantarow, lies in investigation of the physiological character of the conditions rather than of the physico-chemical type.[52]

Howland states that calcification may be visualized in this way. "Serum contains Ca and inorganic P in solution in much higher concentration than water would hold them, on account of the high CO_2 tension. There is some evidence that Ca is bound to protein. If it is assumed that this Ca protein compound is poorly ionized, this would be equivalent to reducing the total Ca concentration. Intercellular fluid of the tissue contains roughly the same amount of Ca and P, according to our determinations, as the serum, but the protein is much less, apparently about 1 per cent, as contrasted with 7-9 per cent in the serum. The CO_2 tension is relatively high on account of cellular activity. But supposing that CO_2 tension is low because the tissue is inactive or dead, then conditions are favorable to precipitation. Cartilage and the trabeculae of bone are both inactive tissues and it is in them that one would expect the CO_2 tension low, and it is in them that precipitation takes place. A precipitation of Ca phosphate always forms if the product of the concentrations of Ca and P in Mg per 100 c.c. is 40 or more."[53] There is considerable evidence to support this theory.[54]

This view sounds highly logical but more experimental data is necessary before any conclusions may be arrived at.

Ca not only is vital in growth but in repair of fracture as well. In this field, too, the exact mechanism by means of which Ca salts are implanted is to a large extent unknown. Tisdall and Harris remark that there is reason to believe that changes in the inorganic metabolism of the body may accompany or perhaps determine the deposit of bone salts.[55]

In their work on rachitic infants, Howland and Kramer note that the inorganic phosphate content of blood serum is markedly reduced. When healing occurs with a deposit of the bone salts, the phosphate content of the serum again assumes a normal level[56] Their theory as stated by Tisdall in more comprehensible form will have a more decided bearing in this case. "The serum and tissue fluid contain Ca and P in a nearly saturated solution; a slight reduction of acidity of the tissue fluid at the point at which the cartilege is in close contact with the circulation from the bone marrow reduces the solubility of these salts and results in their deposit."[57]

The whole subject of fracture is tied up with Ca phosphate deposit. Again Howland states from his determinations that phosphate content of the serum reaches a higher level in infants than in adults. The concentration level falls quite a bit at 19 or 20 years. It is at this age that most epiphyses unite and active bone formation ceases. If, however, fracture occurs, active bone formation recurs and once again the phosphate is elevated to the high level present during the period of normal growth.[58]

Tisdall and Harris point out further that certain drugs influence bone deposit. They recommend specifically Ca phosphate in the treatment of a delayed union of fractures.[59] Blunt and Cowan report that cod liver oil or irradiation will hasten the healing of fractures (predispose deposit of the Ca).[60]

Another function and antagonistic relationship of Ca is demonstrated in membrane permeability. While sodium (Na) ions increase the permeability of cell membranes (shown by numerous workers—among them, Osterhout, Harvey and Loeb and Wasteneys),—Ca diminishes the permeability of certain colloids and most crystalloids.[61]

As early as 1880, Ringer showed the effect of certain ions on cardiac action. His research pointed out that Na, K and Ca were necessary in definite balanced proportions to guarantee normal action. If, for instance, the Ca concentration is decreased, cardiac contractions gradually diminish, then cease entirely. When it is added, more forceful contractions result, but eventually "calcium rigor" (tonic contraction) will develop.

In the process of blood coagulation, Ca salts, especially the chloride, are essential. The fibrinoplastic quality of the blood is increased. Shoemaker (1909) states that the chloride is very helpful in certain operations. Where hemopheliacs are concerned and surgery necessary, the Ca salt is given for a few days and the danger of hemorrhage is overcome.[62]

Hooker has shown that Ca also increases the vascular tone of the blood vessels.[63] Its use in connection with nerve impulses has been pointed out by Locke and Overton. The former pointed out that the lime mineral was necessary for the passage of nerve impulses from the

nerve to the muscle across the myoneural junction. Overton shows its use in transmission near the synapses.[64] Ca influence on nerve and muscle excitability has been referred to above (under Mg relationship).

Ca salts have also an important function in connection with digestion. The rennet ferment of the pancreatic juice cannot act in their absence. Also the addition of lime water or Ca chloride water will aid intestinal indigestion in infants or patients on a milk diet.[65] Cantarow notes the change of caseinogen into casein by the action of Ca and rennin.[66]

He also mentions calcium's minor functions in regulating the reaction of the blood and tissues (acid-base equilibrium) and in the osmotic process (water-balance).

Calcium Therapy

The amenability of various bone diseases and involvements to calcium therapy has long been recognized. Small doses of Ca given for a period of time will bring desired results in case of malnutrition, scrofula or tuberculosis, especially affecting skin or bones, states Shoemaker (1909).[67] Aulde notes that the use of a suitable trituration of Ca with a reorganized dietary in one week has proved efficacious in relieving spinal irritation (marked tenderness and fairly constant pain in the spine) while convalescing from typhoid fever.[68] In another place the reconstructive effect of the mineral in wasting diseases such as arthritis and chronic rheumatism is commended.[69]

He also cites the results that Howland and Marriot (1919) obtained in ideopathic tetany (convulsions). Their analysis of the blood serum show a Ca deficiency of approximately 40 per cent, which was corrected by using Ca chloride in food.[70]

At another point an interesting case report of a 19-year-old girl is referred to. The girl had pronounced spondylitis (spine was very tender); also well-marked pyelitis and anuria which reached a danger point. Along with these conditions were an inflamed left ovary and extreme pains at the menstrual period. Aulde remarks that with medication of Ca sulphide and Ca phosphate in 8 to 10 glasses of water, and a regular dietary, urine promptly increased in quantity, pus disappeared, pain along the spine was less and the ovarian pain gradually subsided.[71]

In his practice, Aulde has noticed that neuritis, neurasthenia, dysmenorrhea, gingivitis, goiter, eczema, intestinal disorders, cholera morbus, cholera infantum, diarrhea and dysentery, nephritis, chorea, or St. Vitus Dance, diabetes, hay fever and spasmodic asthma have been relieved by using Ca salts.[72] The effects of the mineral appear to be more widespread than is ordinarily supposed.

Briggs notes the effectiveness of Ca acetate in correcting phosphoric acid retention in nephritis. He claims this particular salt precludes the disadvantages of alkali retention and the resulting edema observed with Na bicarbonate therapy.[73]

The research of Ca therapy done in the field of rickets has been quite extensive.

Where Ca is deficient in rachitis or removed by disease as in osteomalacia, bones become flexible and unable to maintain the weight of the body. The rational treatment would be the administration of lime salts, according to Shoemaker (1909).[74]

In this field the work of Howland and Kramer has been notable. From their experiments (1922) they estimated that rickets will occur whenever the product of blood calcium by the inorganic P expressed in mgms. per 100 c.c. of blood falls below 30.[75] For a normal child, the product will be 50. Where the product is 40 or more, rickets never results. "In an infant with active rickets in which the serum Ca is normal (10 mg. per 100 c.c.) and the P reduced to 2.5 mg., the resultant product equals 25. Or in an infant suffering from tetany with evidence of mild rickets, the Ca may be reduced to about 6 mg. per 100 c.c., and the P remains normal (5.5 mg. per 100 c.c.). The product is then 33."[76]

Experiments on rats by Shipley, Park, McCollum and Simmonds, led them to believe that there are 2 main kinds of rickets—one a low P rickets and another a low Ca rickets.[77] In other work it was found that diets very high in P and low in Ca would produce changes in bones of rats which differ from rickets. "The bones were thin, the enlargement of costochondral junctions and ends of long bones were slight or lacking. Fractures were not found."[78]

In this connection Tisdall raises the question whether bone changes observed in his work (cranio-tabes and enlargement of the costochondral junctions) were not more of an osteoporotic nature than true rickets. His estimations of the mineral content showed that the Ca and P concentration in the serum of a number of infants with the above-mentioned signs averaged 8.8 mg. Ca and 6.1 mg P per 100 c.c. of serum.[79] (Normal averages are 10.5 mg. Ca and 5.4 mg. P).

The difference between the percentage of Ca retained from cow's milk and human milk (Orgler—see Ca Requirements) is confirmed by Freudenthal.[80] Rickets occurred most frequently in children at the ages of three months to two years, with greater frequency in a child artificially fed than in the breast-fed infant, according to his observations. In rickets the retention of Ca is considerably diminished. Rachitic children when fed with human milk, retained only 15 to 31 per cent instead of the normal 60 per cent.[81] Thus, Freudenthal suggests that the etiology in rickets may be an insufficient supply of Ca or insufficient assimilation or retention of Ca or both together.

Cantarow remarks in this regard that rickets is not exclusively a disturbance of Ca metabolism. A disordered P metabolism is equally important. The mechanism whereby Ca and P are lost from the body is probably a part of abnormal intermediary metabolism.[82]

In the stages of recovery a considerable retention of the mineral was found (the children were given cod liver oil). Korenchevsky found that the ingestion of very large quantities of Ca did not cure rachitic Ca impoverishment of the skeleton of rats on a diet deficient in the fat-soluble factor.[83] The beneficial effect of cod liver oil—vitamin D (fat-soluble) and irradiation—as complementary factors in Ca therapy will not be further discussed here.

That Ca therapy during rickets is not able to improve a negative Ca balance is further substantiated by Shabad, Orgler and others.[84] However, the point is made that when the rachitic organism was in the recovery stage, it was possible to show an increased retention of Ca. Hence, in the progressive stages of the disease, Ca deposit is retarded.

Other disturbances of ossification which will probably prove amenable to careful therapy are osteitis fibrosa, a skeleton disease linked to a disturbance of the parathyroid function in which a hypercalcemia of 14.6—17.8 mg. (constant negative Ca balance) and metastatic calcification (calcific deposits) in the lungs, kidneys and stomach is obtained. Osteomalacia, which is shown to resemble a low Ca form of rickets and hunger osteo-

pathy, a condition due to a diet deficient in total calories, Ca, P and vitamin D, will also benefit.[85]

DOSAGE

The use of different salts of Ca has been previously referred to. Several have been shown to produce effects which certain other Ca compounds will not. The selection of the dosage and the specific compound made by the investigator or physician depends on the individual and the involvement.

The usual technique of intravenous injections of Ca recommended in the treatment of tuberculosis is 5 c.c. of a 5 per cent solution of Ca chloride by a syringe.[86] This has been used as a standard treatment.

Aulde says that Ca chloride is readily soluble in water and can be administered in that medium, but other salts should be given in the form of a trituration—equal parts of crude substance and sugar of milk. This method would favor their absorption as colloids. Further, the salt selected is immaterial since organic salts take no precedence over inorganic. The effect therapeutically will be equally prompt and efficient.[87]

Dr. Aulde goes on to say that the dosage is discretionary, not arbitrary. For a child of five, he recommends 5 grains of trituration, three times a day (2½ grains of crude substance). It is pointed out that in addition the same child will get more than twice this amount from a single glass of milk, but only a bit of the Ca is available, probably as a result of protein decomposition in the intestine due to acidity.[88]

Ten to twenty grains in trituration in the form of a powder or a capsule (before or after meals) are suggested for adolescents and adults. In chronic ailments such as Bright's disease (nephritis), tuberculosis, diabetes, spasmodic asthma and arthritis (chronic rheumatism) a double dose is advocated. This amount should be reduced as improvement is visible.[89] Colloidal Ca is also recommended as beneficial in certain other conditions.[90]

In addition to the use of Ca injections, the importance of using foods with large Ca content is not to be underestimated. Milk and leafy vegetables are the best sources, as shown by many of the investigators. Certain foods in which Ca and P have been removed through manufacture should be noted (for example: sugars, white and processed cornmeal).[91]

The value of concomitant factors in optimal Ca metabolism (such as heliotherapy, hygienic surroundings and adequate diet) should not be overlooked. All are part of the complex picture.

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Manipulative Surgery

Philip Lewin, M. D.

Manipulative surgery is the art, science and practice of the correction of deformity and the restoration of function of bones, joints, muscles, tendons and ligaments by nonoperative means. The object of manipulation is to prevent deformity, to correct deformity and to preserve and restore muscle function.

The general principles include (1) the selection of cases; (2) the contraindications; (3) preoperative care; (4) the technic, and (5) the after-care.

Indications—Manipulation is indicated in cases with adhesions, functional or hysterical cases, unreduced dislocations or subluxations and in a miscellaneous group of lesions. Manipulative therapy is indicated principally in those conditions which follow several weeks after an injury—that is, those lesions due to adhesions rather than arthritis. It is indicated in those conditions where, because a person has assumed a comfortable posture during an acute illness, he develops a contracture—such as an adduction contracture of the thigh or shoulder, or a flexion contracture of the elbow or knee.

Contraindications—One must use fine judgment in the selection of cases. The joint should be "cold." There must be no active infection and no active "heat" in the part. The area must not look "angry."

Manipulation should not be performed unless the general condition of the patient is good, and it should be avoided in elderly and feeble patients. There must be no evidence of active disease. There must be no other active rheumatic areas. A considerable degree of shock may be caused, particularly in elderly persons, by forced movement.

The prerequisites for manipulation include a thorough physical examination and complete roentgenographic studies, which includes adequate diagnostic films.

Before manipulation is carried out, one must rule out tuberculosis, osteomyelitis, sepsis, acute infectious arthritis and neoplasm.

Preparation of Patient—The general preparation of the patient is the same as for an open operation. Anesthesia should include: (1) hypodermic injection of morphine and atropine one hour before manipulation; (2) induction with nitrous oxide or ethylene, and (3) complete anesthesia under ether. Manipulations of the back, pelvis and legs can be done under spinal anesthesia. The anesthesia as a rule should be gas induction followed by ether. It cannot be done under a "whiff of gas."

Technic of Manipulation—The position of the patient and surgeon are essential to correct manipulation. For example, it is preferable to manipulate the back, pelvis and legs while the patient is on the floor. The sense of touch, a careful blending of caution and determination in technic and after-treatment are more important than physical strength on the part of the operator. The use of extreme force is never necessary and may lead to injury to the bone, muscles, blood vessels, nerves or other important adjacent structures. In those cases in which adhesions are so dense that extreme force would be necessary, Fisher advises open operation, or open operation combined with manipulation. The results of manipulation vary according to the degree and strength of adhesions and the force necessary for their disruption. In mild cases no retentive apparatus is necessary; in the severe cases it is wise to splint the limb temporarily.

For the psychic effect, some operators allow the patient to waken from the anesthesia so that he might observe the increase in movement. The author does not allow this because ether is used, and moreover patients usually forget what they have seen while semiconscious.

Eighteen General Points on Manipulative Surgery[1]

1. Never manipulate in the presence of tuberculosis, osteomyelitis, acute infections, acute arthritis, sepsis or neoplasm.
2. There must be no signs of active infection, *i. e.*, the joints must be "cold."
3. Never manipulate without recent roentgenograms.
4. Never manipulate an arthritic patient without uric acid determination of the blood to rule out a gouty process.
5. Complete relaxation usually requires ether anesthesia.
6. The fact that the patient is asleep does not give the surgeon the right to hurt him.
7. Do not use a limb or part of a limb as a pump handle.
8. "Non vis sed arte." Not by force but by skill.
9. If the objective is to obtain flexion, one should obtain extension first.
10. "You can always go back for more."*
11. Remember the bones are usually atrophic but the ligaments are not, and that bone will break before the ligaments "give."
12. Remember the bone and joint changes are always worse than the roentgenogram indicates.
13. If you break a bone, you cannot start early motion.
14. Breaking an adhesion causes hemorrhage, and hemorrhage is the starting point of another adhesion.
15. A stretched adhesion causes pain; a torn adhesion does not cause so much pain, therefore, do not stretch adhesions—break them.
16. Never immobilize a member in the position of maximum correction.
17. Never manipulate unless you are prepared to supervise the after-care.
18. The patient should make active movements at the earliest possible moment following the manipulation.

After-care—The surgeon must be willing to supervise the after-care. A cast or other retention apparatus

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*This expression is used chiefly for teaching purposes. Very rarely should a joint be manipulated more than once.

may be used for a few hours, but usually none is necessary. If possible, physical therapy should be given the same afternoon and night. Narcotics should be avoided, if possible, and the part should be kept in active motion.

The joint should be put through its full range of movement daily to prevent any tendency to recontracture, particularly in those cases following arthritis. The patient is instructed in a few simple exercises which should be performed for a few minutes morning and evening. "A movement a day keeps adhesions away" (Coates).

Sir Robert Jones found that certain symptoms, following manipulation and passive motions, indicating injurious strain, may thus be formulated: if pain occurs after manipulation, and is of short duration, movements may be continued. If pain persists for a long period after manipulation, rest is indicated. If the increased range of movement is maintained after manipulation, further movements can be prescribed. If, in spite of movements, even in the absence of great pain, the range is continually diminishing, rest is indicated. The duration of pain when tissues are relaxed, rather than its intensity, should be the clinical guide. In overcoming adhesions and in subsequent manipulations, the joint should be put through its movements only once. Voluntary movements can be safely allowed and should be encouraged.

LOW BACK AND PELVIS MANIPULATIONS FOR DIAGNOSIS

Goldthwait Test is performed with the patient lying supine with both legs in extension. The straight leg to be tested is flexed on the abdomen. Normally this limb can be carried to a position of a right angle with the body before pain, muscle spasm or shifting of the pelvis occurs. In sacro-iliac and lumbosacral arthritis this is impossible.

Lasègue Test or "straight leg raising" test consists in raising the leg from the table with the knee extended. By keeping the knee extended the hamstrings gradually become taut and leverage is transmitted unilaterally to the pelvis. If the sacro-iliac joint on that side is sensitive, this test produces pain.

Lewin's Corollary Test—When performing the Lasègue test, note is made of the angle reached when the extended knee on the opposite side begins to flex.

A protractor for measuring the angle subtended by the straight leg and the examining table in carrying out the Lasègue test is desirable (1) to assist in the diagnosis, and (2) for comparison during the course of treatment.

Kernig Test is similar to the Goldthwait and Lasègue signs except that after the thigh is flexed on the abdomen with the knee flexed, the knee is extended. When the test is positive, the latter movement cannot be accomplished.

Smith-Petersen Test is similar to the Lasègue and Goldthwait.

Fabere-Patrick Test—In Patrick's test with the patient supine the thigh and knee are flexed and the external malleolus is placed over the patella of the opposite leg; the knee is "hung up" and when it is depressed, pain is produced, indicating a lesion of the hip. Patrick calls this the fabere test from the initial letters of the movements necessary to elicit it: *f*lexion, *ab*duction, *e*xternal *r*otation, *e*xtension.

Gaenslen Test is carried out as follows: while one hip and knee are held acutely flexed, which fixes the lumbar spine and lumbosacral joint, the other hip is put into hyperextension with the knee extended. If this produces pain it localizes the lesion to one of the sacro-iliac joints. The writer has modified Gaenslen's test by having the patient lie on one side, flexing the thigh and knee of the under side with the hands and holding the knee flexed as completely as possible. Then the examiner manipulates the upper limb with knee extended, producing hyperextension. The patient then holds the upper limb while the lower is extended. This obviates the necessity of moving the patient from one end or side of the table to the other.

Lewin Test—The following test has been found to be of value in certain cases. It is performed while the patient is standing with his back to the examiner. He is instructed to bend forward and touch his toes. He usually flexes his knees to a greater or lesser degree in order to carry out this command. While standing in this position with his fingers touching his toes, the examiner, gently at first, and later forcibly, forces the right and then the left knee to complete extension. In cases of low back pain due to lumbosacral, lower lumbar, sacro-iliac and gluteal disturbances, these movements will be accompanied by pain and the knee will snap back into flexion with a degree of resiliency.

Yeoman Test—While the patient lies prone on the table, the knee is flexed and firm grip is taken of the ankle while the other hand is placed over the sacro-iliac joint. The hip is then passively hyper-extended by lifting the knee off the table while the pelvis is kept on the table with the other hand. This maneuver stretches the anterior sacro-iliac ligament and elicits pain in the presence of a lesion in the joint. In a normal person this action is painless.

Ely's Sign—In inflammatory and traumatic lesions of the lumbar spine, if the patient is laid on his face, his pelvis will rise from the table when his knee is hyperflexed by touching his buttock with his heel. This helps to differentiate lumbar from sacro-iliac lesions.

Lewin Test—In lumbar, lumbo-sacral, and sacro-iliac, arthritis and especially with the sciatic syndrome, the following test has been found to be of value. While the patient is lying supine with his legs in extension, the examiner places his arms or a large strap transversely across the patient's thighs just above the knees. He is then instructed to sit up straight. In lumbar arthritis or sciatica he is unable to do so and indicates the area made painful by the movement. In advanced cases the sign is striking.

Lindner Sign—If enforced passive flexion of the head to the chest is affected in a recumbent or sitting posture with outstretched legs, pain arises in the lumbar region, in the sciatic area, sometimes down the entire leg on the affected side. Shambouroff believes that the Lasègue contralateral sign and the Lindner sign are indications of root sciatica.

Neri-bowing Sign—When the patient in the standing position is made to bow he flexes the knee on the affected side as if he were making a courtesy, which causes pain in the leg.

Yergason Test—The patient, who is standing before an ordinary chair firmly held with the surgeon extending a hand for the patient to grasp, is asked to step up onto the chair. It is surprising how many patients accomplish this act with the attention centered on the upstepping leg, which naturally seems to be the one in which the examiner is interested. With the direction then to step down, the surgeon, still holding the hand, exercises a slight push through the forearm so that the patient steps down unexpectedly, producing a slight jar which is transmitted upward through the weight-receiving extremity. The surgeon then changes his hand

upon the chair and extends the other, repeating the procedure, testing the opposite leg of the patient. With genuine joint trouble, the patient cannot perform this test without complaint. The sacro-iliac malingerer will step down hard on the foot of the "affected side" without complaining of pain.

Mennell's Sign—In eliciting Mennell's sign an examining thumb is placed over the posterosuperior spine of the ilium and then made to slide first outward and then inward. If, on pressure over the former point, tenderness is detected, it indicates a sensitive deposit in the structures of the gluteal aspect of the posterosuperior spine. If the tenderness is over the inner point, it is probable that the superior ligaments of the sacro-iliac joint are strained and sensitive. If the tenderness is increased by pressure backward on the anterosuperior aspect of the ilium and decreased by pulling forward the crest from behind, it is caused by sensitive ligaments.

Lewin Stair Test—If a person steps down a stair unconsciously he jars his pelvis and back. If a blindfolded patient is led up a small flight of stairs and taken down all but one stair and then told to walk off on a level, he drops down the height of the stair. This jars his pelvis and back and causes pain which can be localized.

Magnuson Sign—Magnuson found that patients with pressure on the lumbosacral plexus, by the lateral process of the fifth lumbar vertebra cannot bend towards the side of injury. Pain is increased by bending toward the side which is affected. There is a tender spot over the fifth lumbolateral process in the space bounded by the crest of the ilium, the posterior superior spine, the fifth lumbar spine and the muscles of the lumbar region. If a patient rotates his body toward the side of injury, he throws the fifth lumbar in closer contact with the sacrum which causes pain. The lumbosacral cord has a definite distribution and there should be some atrophy if the case is one of real pressure. Spasm of muscles may be set up by irritation of the nerve, by having the patient bend toward the side of injury.

MANIPULATION OF LOWER BACK

The following are the chief methods of manipulation of the lower back:

Baer Maneuver—According to his technic, the patient is placed on a low, solid table, flat on his back, and then anesthetized. The anesthesia should be carried to the point of complete relaxation of all muscular tissue, for the force to be exerted at times is great and muscular rigidity carries with it some danger to the patient. While an assistant holds the pelvis firmly, the operator grasps the calf of the leg and flexes the fully extended limb. The hamstring muscles are often found to be in a state of spasm. As the fully extended leg is flexed on the thigh, the hamstring muscles pull on the tuberosity of the ischium and the top of the ilium is pulled backward to meet the sacral junction. This procedure of stretching is carried on until the hamstring muscles are thoroughly relaxed, a state indicated by the fact that the fully extended leg can be flexed to a position far beyond a right angle; in fact, the dorsum of the foot almost touches the shoulder. A definite click is often heard during the manipulation. Baer believed it was caused by a slight subluxation of the head of the femur as it pushes against the hamstring while the leg is in extreme flexion. The presence of the click is synchronous with release of the hamstring muscles and indicates that the objective has been accomplished. The flat back has been replaced by a back with lumbar lordosis. Care should be taken in the manipulation, for with careless handling one may produce a subluxation of the knee joint backward, causing a paralysis, or one may cause a fracture of the head of the femur.

After the manipulation has been completed the patient is placed on a Goldthwait frame and put up in a plaster-of-paris cast extending from the nipple line down to the knee on the affected side. This is done to preserve the reformed lumbar lordosis. The patient remains in this cast in bed for a period of ten days and a small pelvic strap is worn for two months.

Fisher's Manipulation is similar to the one described by Baer.

Magnuson Technic—In this treatment the patient is placed on his back with the affected half of his body projecting several inches from the side of the table. The affected limb is manipulated as in the Baer manipulation and from this position of hyperflexion is suddenly thrust into the position of hyperextension. The second part of the manipulation consists in locking the hands under the patient's lumbar spine and giving him a sudden pull upward in order to increase the lumbar lordosis.

Cox's Technic—This manipulation is similar to Nutter's. The patient is placed on a table face downward, his weight being supported on the elbows and abdomen and his hands securely grasping the edge of the table. The surgeon, while standing on a box near the feet of the patient, firmly grasps the ankles and lifts the body clear of the table, the body being supported above by the elbows alone. It is held in this manner for several minutes with the legs in abduction, strong and steady traction being made on the affected side while an assistant makes firm pressure over the sacrum. The body should be lifted up and down while the traction is being made. There is usually sudden marked relief as the bones "slip into place," and the lumbar curvature is in most instances restored at once. The patient can lie face downward on the floor and hold on to a radiator. The mechanism is thought to be as follows:

The dragging position of the suspended body together with traction on the affected side, which relaxes the joint, and firm pressure over the sacrum will tend to replace the bones, thus fulfilling Gunn's rule for reducing any dislocation.

In Magnuson's and Cox's technic, after replacement, a firm support of adhesive tape is passed behind from in front of one great trochanter to the other. It is essential to place the support low, well down on the buttocks, below the level of the trochanter as any lateral pressure above this point tends to separate the joint and produces great pain. The straps should extend from the anterior part of the ilium on one side to a similar point on the other side and should cover the buttock and lower lumbar spine below the trochanter. A firm pad of cotton or felt over the sacrum will maintain pressure on it at all times. This dressing should be reapplied in about six days. The patient should be put to bed for one week if the displacement is acute, and a small firm pillow should be so placed as to maintain the lumbar curvature and keep any strain off the injured ligaments.

Lewin's Routine—Following is the comprehensive manipulation which the author recommends:

1. Flex the thigh of the unaffected side on the abdomen (knee flexed).
2. Flex the thigh on the affected side.
3. Flex the thigh on the unaffected side (knee extended), i. e., perform the Lasègue test.
4. Flex the thigh of the affected side till the toes approach the anesthetist's cap.

5. Perform the fabere test of the unaffected side.
6. Repeat the test on the affected side.
7. Stretch the Achilles tendon of the unaffected side (in case of unilateral sciatic pain).
8. Stretch the Achilles tendon of the affected side.
9. Stand over the patient, straddling his body; lock both hands under his lumbar spine and hyperextend the lumbar region.
10. Perform the Gaenslen test on the unaffected side, then on the affected sacro-iliac joint.
11. Do the Magnuson manipulation on the unaffected side, then on the affected side.
12. Do the Cox manipulation.
13. Then remove the ether mask. Elevate the patient to the sitting position. Hold his head firmly; hyperflex the back until his head can be placed between his knees. Bend the back toward the affected side. Bend the back away from the affected side.
14. Resume supine position and repeat maneuvers 3 and 4.
15. Do straight leg raising on the unaffected side, then on the affected side.
16. Forcibly hyperflex both thighs at the same time on the abdomen while both knees are held in extension, i. e., double exaggerated Lasègue or double Kernig tests.
17. If a good sacro-iliac belt is not at hand, one should strap the entire pelvis with adhesive tape.
18. If it is a unilateral case, leg traction should be applied to the affected side and the foot of the bed elevated about 8 inches.

In sciatic scoliosis one should stretch both sides, the unaffected side first and not so severely as the one affected.

MANIPULATION OF THE NECK

Manipulation of the neck is one of the most delicate and may be one of the most harmful procedures to which a patient may be subjected. The chief indications for manipulation of the neck are adhesions, arthritis, subluxation, torticollis and dislocation. One should be very cautious. The maneuvers are carried out under gentle traction, exerted on the chin and occiput. Gentle flexion of the head is followed by extension, then lateral bending, so that one ear touches the shoulder of the same side, then the other side; then gradual rotation to the right and left.

Hanflig[2] believes that if the arthritis is subacute or chronic, stretching and manipulations are indicated. An overhead hook into which can be attached a block and tackle Sayre sling suspension apparatus is needed. The patient is seated on a chair under the apparatus.

The Sayre sling, well padded at the chin pieces and occiput piece, is applied. Traction is applied and is continued until the patient's buttocks swing freely, when rocked, just above the seat of the chair. While the patient is suspended in the air, the shoulders are held by an assistant, and the head and Sayre sling are rotated to the left and right. The patient is then lowered and rested for a moment or two, and then the entire procedure is carried out again.

A Thomas collar is made and applied to be removed only for the hot fomentations to the neck that follow each treatment.

It has been customary to carry out this treatment three times the first two days, twice a day thereafter, and then spaced out as seems advisable.

COMMENTS

All manipulations should be performed by a surgeon and he should supervise the after-case. The physical therapist should know what has been done in a manipulation, so she can more intelligently give the necessary physical therapy in the after-care. The most important part of this physical therapy is: The patient should make active movements at the earliest possible moment following the manipulation.

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Approved Schools for Physical Therapy Technicians

The cooperation of the Council on Physical Therapy, the American Congress of Physical Therapy and the American Physiotherapy Association was secured in determining minimum educational requirements for physical therapy technicians. "Essentials of an Acceptable School for Physical Therapy Technicians" were adopted by the Council on Medical Education and Hospitals and passed by the House of Delegates of the American Medical Association at the Kansas City meeting, May 9, 1936, as a result of the resolution introduced by Dr. C. B. Reed of Illinois. The first list of approved schools appeared in THE JOURNAL, Aug. 29, 1936, and the schools listed here represent the first revision.

As for other types of medical assistants, there exist many commercial schools for physical therapy technicians throughout the country. Although they are self styled as schools of physical therapy, instruction given in courses of this type consists principally of concentrated massage training. Extensive advertising is used to secure students who are not aware that standards and a registry exist and that short courses are not as a general rule considered acceptable to hospitals and clinics employing technicians. Naturally, such schools are primarily interested in revenues and as a rule do not adhere to standard requirements for admission and curriculum. Students turned out by commercial schools find their field of employment limited to massage establishments, clubs, gymnasiums, and so on; positions as assistants in hospital physical therapy departments or with members of the medical profession are virtually closed to them.

It has become increasingly apparent that many trained as "physical therapy technicians" in commercial

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schools infringe on medical practice and too often are not prosecuted. Those trained in acceptable schools become thoroughly imbued with the necessity of working under the supervision of a qualified physicion at all times and thus they become bona fide medical technicians.

The Council's essentials have been prepared with the purpose of designating acceptable basic courses covering all the more important phases of physical therapy. The essentials were printed in THE JOURNAL, Aug. 29, 1936, and may be secured through the office of the Council. Additional schools will be considered on application and placed on the list when they are found to comply with the requirements.

The American Registry of Physical Therapy Technicians, sponsored by the American Congress of Physical Therapy, accepts for examination graduates of schools approved by the Council on Medical Education and Hospitals. Information regarding the Registry may be secured through Miss Marion G. Smith, registrar, 30 North Michigan Avenue, Chicago.

Schools for Physical Therapy Technicians Conforming to the Standard Adopted by the American Medical Association in 1936

Name and Location of School	Direction	Entrance Requirement	Length of Course	Student Capacity	Tuition	Certificate Diploma, Degree
Children's Hospital, Los Angeles[1]	John C. Wilson, M.D.	(a) R.N. (b) Grad. phys. ed.	12 mos.	10	$125	Diploma
Stanford University Hospital, San Francisco	W. H. Northway, M.D.	(a) R.N. (b) Grad. phys. ed.	12 mos.	..	$175-$250	Certificate
Walter Reed General Hospital, Washington, D. C.[2]	Maj. W. W. McCaw, M.D.	Grad. phys. ed.	12 mos.	10	None	Certificate
Northwestern University Medical School, Chicago[3]	John S. Coulter, M.D.	(a) R.N. (b) Grad. phys. ed. (c) 3 yrs. coll.[a]	9 mos.	7	$200	Certificate
Bouvé-Boston School of Physical Education, Boston[4 b]	Howard Moore, M.D.	High school grad.	3 and 4 yrs.	6	$400 yr.	Diploma or B. S.
Harvard Medical School, Course 445, Boston[5]	F. R. Ober, M.D.	(a) R.N. (b) Grad. phys. ed. (c) Coll. grad.	9 mos.	16	$150	Certificate
Boston University, Sargent College of Physical Education, Cambridge, Mass.[6]	Prof. E. Hermann, Dean	High school grad.	4 yrs.	25	Univ. fees	B.S.
Battle Creek College, Battle Creek, Mich.[7]	Paul Roth, M.D.	(a) R.N. (b) 2 yrs. coll. (c) Grad. phys. ed.	12 mos.	..	$250	Certificate or B.S.
St. Louis University School of Nursing, St. Louis[8]	A. J. Kotkis, M.D.	High school grad.	4 yrs.	7	Univ. fees	B.S.
University of Buffalo, Buffalo[9]	G. G. Martin, M.D.	R.N.	18 mos.	2	Univ. fees	B.S.
Hospital for Ruptured and Crippled, New York City[10]	K. G. Hansson, M.D.	(a) R.N. (b) Grad. phys. ed.	9 mos.	8	$300	Certificate
D. T. Watson School of Physiotherapy, Leetsdale, Pa. (affiliated with Univ. of Pittsburgh School of Medicine)[11]	Jessie Wright, M.D.	(a) Grad. phys. ed. (b) 2 yrs. premed.	22 mos.	8	None	Diploma
College of William and Mary, Richmond, Va.[12]	Committee on Physical Therapy	(a) R.N. (b) Grad. phys. ed.	9 mos.	..	Coll. fee	Certificate
University of Wisconsin, Madison[13 c]	E. A. Pohle, M.D.	(a) R.N. (b) Grad. phys. ed.	12 mos.	20	Univ. fee	Certificate

NOTES

a. Including 26 semester hours of the following subjects: physics, chemistry, zoology and biology.
b. Four-year course leads to B. S. degree from Simmons College.
c. M. S. degree for advanced work.

AFFILIATED CLINICAL FACILITIES

1. Glendale Sanitarium and Hospital, Glendale; Good Hope Clinic and Los Angeles County Hospital, Los Angeles.
2. Weightmann School for Crippled Children, Washington, D. C.
3. Michael Reese Hospital, Montgomery Ward Clinic, Passavant Memorial Hospital and St. Luke's Hospital, Chicago.
4. Boston City Hospital, Children's Hospital, Massachusetts General Hospital and Robert Breck Brigham Hospital, Boston; Cambridge Hospital, Cambridge, and Newton Hospital, Newton.
5. Boston Home for Incurables, Convalescent Home of the Children's Hospital, Children's Hospital, Harvard Infantile Paralysis Commission Clinic, Industrial School for Crippled and Deformed Children, Massachusetts General Hospital, Perkins Institute for the Blind, Peter Bent Brigham Hospital and Robert Breck Brigham Hospital, Boston, and Cambridge Hospital, Cambridge.
6. Industrial School for Crippled and Deformed Children, Massachusetts General Hospital, Massachusetts Memorial Hospitals, and Perkins Institute for the Blind, Boston, and Cambridge Hospital, Cambridge.
7. Ann J. Kellogg School, Battle Creek Sanitarium, and other hospitals in Battle Creek.
8. Firmin Desloge Hospital, St. Louis.
9. Buffalo City Hospital, Buffalo.
10. French Hospital, New York Polyclinic Hospital and Reconstruction Hospital, New York City.
11. Allegheny General Hospital, Children's Hospital, Elizabeth Steel Magee Hospital, Falk Clinic, Industrial Home for Crippled Children, and St. Francis Hospital, Pittsburgh.
12. Stuart Circle Hospital and Wheeldon Clinic, Richmond, and others.
13. State of Wisconsin General Hospital, Madison.

Physical Therapy in Delayed Union of Bone*

Gordon Mackay Morrison, M. D.

The common locations of delayed union are the tibia, humerus, ulna and femoral neck (the latter in a class by itself and not considered in this paper).

Tibial fractures at the junction of the middle and lower thirds, more particularly those which have compounded, present a good example of a delayed union in the average healthy person. By delayed union I mean, in this instance, no x-ray evidence of bone formation after ten or twelve weeks' time.

Mid-shaft humeral fractures and fractures of the ulna, junction of the middle and upper thirds also offer problems in delayed union, but for our purposes we will discuss fractures of the lower leg, since they are usually more of a problem.

Causes of Nonunion

Amongst the causes of delayed union, the more common ones are: inadequate immobilization, muscle or fascia between the fragments, systemic disease or altered blood chemistry, the relation of location of nutrient vessels, compound fractures and *too much traction.*

Imperfect immobilization in certain fractures, notably those of the humerus, forearm and tibia seems to be a very definite cause of nonunion.

The factor of overtraction has become an important one in these days of many forms of apparatus for skeletal traction. It is a matter of experience undisputed, I think, that traction that leads to actual separation of bone, even for a matter of a few days, leads to nonunion. Presumably this is due to the intrusion of indifferent granulation tissue into the gap. At all events, it happens so often that the point is worth stressing. Traction, of course, is to be used, but it is never to be used in such fashion as to separate fragments. It is worth while, therefore, with traction on, to check carefully on this point with portable x-ray, and if the distraction of fragments is discovered to let up on the pull very promptly.

There is a distinct group of cases in the young, vigorous adults on up to the vigorous middle-aged persons, who show perfectly normal blood chemistry by all the tests that the laboratory knows, yet they have a delayed bony union. Certain of these cases may go along for months up to a year or more, and then suddenly, by a homogeneous blending of bone, with no callus formation visible by x-ray, union forms. This must be a strictly local condition, but we do not know exactly what has happened. It must be local, since in a large percentage if operated upon, and one or another of the bone grafting operations is done, union occurs. I have reference to that type of nonunion which does not show evidence of pseudarthrosis with eburnated ends of fragments. This latter type must, of course, be operated upon since the bone ends are so sclerosed and hard that it is necessary to clean out back to normal bone marrow for adequate blood supply.

590 Commonwealth Avenue, Boston, Mass.

*Read before the Fourteenth Annual Meeting of the Academy of Physical Medicine, held in Boston, Mass., October 20, 21 and 22, 1936.

Reprinted from "The Medical Record," April 7, 1937.

Local Findings Clinically

The local findings clinically of a typical case of delayed healing in lower tibial fracture are: motion of the ends of the bone between the fingers, some degree of tenderness on the most gentle manipulation, puffiness of the lower leg, ankle and foot. In many cases one sees visible signs of feeble circulation. The dorsalis pedis vessel is rarely of normal character and tone. The tissues of the lower leg and foot tend to be edematous and are pale, but cyanotic when the foot is put down. Such a case, if it has been properly checked by x-ray and has been immobilized from eight to twelve weeks, ordinarily presents such a picture. Films show much osteoporosis —thinning out of bone texture.

Treatment

It is not the purpose of this paper to bring in, otherwise than superficially, operative treatment of delayed bone union, but rather to emphasize the importance of careful, adequate scientific physical medicine. What are the possibilities of providing such a patient with a strong bone union *short* of operative treatment? First of all, adequate support in the form of a brace with shoe attachment, usually running up to just below the knee. There is a controversial question as to whether or not weight bearing should be allowed in order to stimulate bone growth. Many such cases as we have here in question will begin to solidify by the stimulus of slight motion and end to end compression provided by partial weight bearing. Certain other cases will absorb whatever slight repair may have occurred. Furthermore, we know that one of the chief causes of delayed or frank nonunion is incomplete immobilization. So, then, one should be careful in choosing the proper case for this early weight bearing.

At this time I wish to emphasize that joint motion must be preserved in the affected limb. Here again we may run into trouble. Particular protection must be afforded the fracture site during flexion of the knee and motion of the ankle once the diagnosis of delayed union has been established.

Types of Treatment Available

(1) Heat and massage; (2) diathermy; (3) intravenous protein therapy; (4) Buerger's exercises; (5) hygiene, vitamin therapy and diet; (6) suction pressure therapy.

Heat and massage of the entire limb from toe to groin, daily if practical, without disturbance of position,

is of inestimable value. This should be done only by the most skillful and trained hands.

Deep heat in the form of diathermy undoubtedly produces some increased collateral blood supply and in this manner aids bone healing. It has been said with regard to diathermy that too much may not only inhibit repair but may destroy it. There has been in the past too much random diathermy in the hands of persons who lack the first principles of proper knowledge of the subject. This is still going on. In fact, a few of the educated class of patients occasionally bring up the question as to whether or not diathermy is really a sugar-coated pill. I wish to emphasize at this point that we should all work toward discouraging the abuse of such a helpful agent. In *proper hands,* then, diathermy is a very useful adjunct to our list of reasonable forms of treatment.

There was at one time the hope that something could be done in the way of deep ray treatment. As far as our data go x-ray in very heavy doses does inhibit growth in the very young individual—in the animal and presumptively in the child. There has been some question whether very frequent x-ray *examinations* may lessen the chance of union. As far as scientific data go on this it is very likely that lugging the patient up and down to and from the x-ray room in the first few weeks may cause trouble but the effect of a reasonable amount of x-ray seems to have proved singularly neutral for or against bone union. Use portable x-ray. The only moral to be drawn here, perhaps, is that too much zeal in using the x-ray, like too much zeal in attempted re-reduction may well inhibit bone growth.

In a certain rather small percentage of cases of non-union one sees the spastic circulatory type, a symptom complex as result of sympathetic nerve disturbance—"Sudek's atrophy" or "traumatic arthritis." In these cases intravenous protein therapy often proves valuable, the treatments to be given a week apart, and may help to dilate peripheral vessels. This traumatic arthritic type is, of course, circulatory in character, nervous in origin.

Buerger's exercises may be considered of value in certain fracture cases accompanied by vessel difficulty.

General hygiene should be lived up to carefully, building up resistance to an optimum. A well-balanced diet with fruit juices, dairy products and green vegetables should be taken.

Vitamin Therapy

Of recent years study of the influence on calcium and phosphorus metabolism exerted by the vitamins, particularly vitamin D, have been much under consideration, and rightly so. We always hoped such control in the laboratories would give us the valuable means of controlling these repair processes in the human patient. In so far as concerns some of the actual systemic diseases such as rickets, this has not been a disappointment. In so far as it applies to repair of bone damage, which is to say, fractures, the situation has not been so happy. All of us have given vitamin D in great quantities for years and with it excess in calcium in the diet and the cod liver oil traditionally valuable. It seems probable that these may have some effect but as a definite treatment with definite results on fracture union they have not proved reliable. Moreover, the chance of overzeal in this matter may lead to more lime in the vessels or the renal system than we wish. The whole thing is still, we feel, an open question.

Perhaps one more form of therapy will prove extremely valuable to our problem. Suction pressure therapy by the Pavex passive vascular exercise instrument or with the vasculator. These machines are fairly new and their purpose is to dilate small collateral arteries and rid the limb of venous blood alternately by the production of positive and negative pressure rhythmically. Color changes in the skin, qualitative and quantitative skin tests suggest improvement of the part after suction pressure therapy. It is believed by some that these changes mentioned last longer than by other means of therapy at our command. Contraindications to this form of treatment seem to be venous thrombosis and infection either in the form of open wounds or phlebitis. This instrument, like other useful methods of treatment, may carry with it certain dangers and therefore should be used cautiously by physicians experienced in vascular diseases.

As a matter of actual routine we are using diathermy and vitamin therapy in selected cases for what they are worth and intravenous protein therapy occasionally, but it has been our experience that in the average case skillful massage following infrared radiation, together with regulated exercises, proves the safest and most practical way of handling this problem.

In the second year of the Taihō Era (702 A. D.) the Code of Laws . . . contained regulations concerning medicine and education analogous to those of the Tang Dynasty from which they were derived. According to this book of law the medical schools as well as those of other sciences were in a high school, *Daigaku,* and in provincial schools, *Kokugaku.* The medical high school, which was in the city of Imperial residence, could take only students from families of the fifth grade or upward, while the provincial medical schools, of which there was one in each province, gave instruction to the youth of the government. The high school belonged to the medical magistrate of the court ministry and comprised five divisions, viz: the medical part, acupuncture, massage, exorcism, and pharmacology. . . . Acupuncture comprised the introduction of needles and small operations. In the massage department (in a three year course) they taught massage, the treatment of fractures and bandaging.—*From "JAPANESE MEDICINE" by Y. Fujikawa, M. D.*

The Physiotherapy Review

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For sixteen years the American Physiotherapy Association has worked unceasingly, through its members and as an organization, for high standards of education. To each of us it has brought a recognition by the medical profession that we as members do meet specified qualifications. Upon each of us then rests a responsibility to be worthy of the Association and to work for still greater attainments. Without our Association there would be confusion, but together we have a unity and oneness of purpose that cannot be denied.

The American Physiotherapy Association stands at the threshold of a great future. Each year there are more graduates from our schools. This means members with a fresh point of view and with new enthusiasms. Young members are a challenge,—they demand the best of training and the largest scope for their potential abilities. It is our responsibility to welcome every graduate into our Association. They should be acquainted with the history, development and accomplishments of the Association in order that they may have adequate preparation for their future responsibilities. Put them on committees —urge them to take an active part in the business meetings.

We learn in biology that growth is a symbol of life. By accepting the changes of an advancing profession and through increased membership the Association grows not only in number but also in scope. We must uphold the standards of the past if we are to keep faith with our predecessors and do our duty to those who come after us.

News Notes

The Sixteenth Annual Scientific and Clinical Session of the American Congress of Physical Therapy will be held September 20, 21, 22, 23, 24, 1937, at the Netherland Plaza Hotel in Cincinnati, Ohio.

The examination for the American Registry of Physical Therapy Technicians will be held on Monday morning, September 20, at nine o'clock in Parlors A, B, C and D of the hotel.

The exhibit of "Improvised Home Apparatus in the After-Care of Poliomyelitis" prepared by the American Physiotherapy Association and the Visiting Nurse Association of Chicago which was shown at the Annual Session of the American Medical Association in Atlantic City, June 1937, will be displayed in the scientific exhibits at the Sixteenth Annual Scientific and Clinical Sessions of the American Congress of Physical Therapy. The American Physiotherapy Association will be represented by Miss Jessie L. Stevenson, Supervisor of the Infantile Division, and Miss Annie Prochazka, Relief Nurse for the Infantile Division, Visiting Nurse Association of Chicago, who will be in charge of this booth and will give demonstrations of the making of splints.

The Fifteenth Annual Meeting of the Academy of Physical Medicine will be held at the Hotel Walton, Philadelphia, October 19, 20, 21, 1937.

Josephine L. Rathbone, Teacher's College, Columbia University, has left for an extended stay in the Far East. Her first stop is India, and she hopes to spend the first six months of 1938 in China.

Bertha Madison, of Riverside, California, attended the International Council of Nurses in London, July 19-24, 1937.

Margaret Bao, a student of Mary McMillan at Peiping Union Medical College, has registered at Northwestern University Medical School for the course in physical therapy.

Sue Roen, of Los Angeles, California, has just returned from three months vacation in Europe. While driving in Lucerne, Switzerland, she noticed a white clad young lady with a familiar blue and gold insignia on her arm. She quickly stopped and called, "Yoo, hoo! American Physiotherapy Association!" whereupon the girl turned around and the two members proceeded to make themselves acquainted. Ginetta Elmiger, the other physical therapist, divides her time between the county hospital and a private office.

ABSTRACTS

John S. Coulter, M. D.

The Adolescent Sacro-Iliac Joint Syndrome*

Mark H. Rogers, M. D., and Edwin N. Cleaves, M. D.

For many years, we have recognized that there is a group of patients of the adolescent age who show symptoms of stiffness of the low back and pain and tenderness over the sacro-iliac joint, often with sciatic pain and peculiar gait due to the loss of straight leg raising. Many of them so persistently fail to improve under routine treatment and the x-ray findings are of such a nature that the question is raised as to whether there is a real joint lesion, such as tuberculosis or infectious arthritis. Some years ago, when vigorous stretching and manipulation under an anaesthetic were routine forms of treatment, we became convinced that during adolescence such patients were often made worse by this methods, since the rigidity and loss of motion persisted for months.

Sometimes the symptoms described appear in the rather stocky boy or girl, who is a little overweight and shows some of the characteristics of the Fröhlich type. It has been observed that such individuals may seem older than the average adolescent, yet they show definite signs that epiphyseal growth is still taking place. Sometimes they are considered good football material, especially for the line, on account of their weight, but some slight strain causes the symptoms to appear. The patients are then strapped, baked, and manipulated, and exercises are given. When there is no improvement and the x-rays suggest certain changes in one sacro-iliac joint, there comes the suspicion of bone pathology. This is the clinical type which we wish to discuss.

The physical findings are quite definite. In the severe types there may be a real protective list, away from the side of the symptoms. On standing, the motions are restricted,—forward bending is limited, while lateral bending is more restricted on one side than on the other. There is localized tenderness over the posterior ligaments of the sacro-iliac joint. With the patient in the recumbent position, the straight-leg-raising test is very much restricted and is accompanied by sciatic pain in the severe cases. On walking, there is the characteristic short-stepping gait on the side involved, which corresponds to the limitation of motion. The whole picture centers around one sacro-iliac joint,—tenderness, restriction of motion, and sciatic pain that may be quite disabling and that tends to recur on slight injuries or strain.

Children of school age do not ordinarily strain the low-back and sacro-iliac regions as readily as do older persons; therefore, when we have to deal with such a group of symptoms in the adolescent period, we begin to search for some underlying cause. In these cases it is difficult to trace the condition back to any one definite injury. Some slight strain during play, not sufficient at first to create a definite impression, is the common source. Once the symptoms start, however, repeated injuries aggravate the pain and stiffness.

We were very much interested in a study of the x-rays of this group of cases, to see whether we could point out any changes in the sacro-iliac joints that might be characteristic. This required a careful consideration of what the normal or average adolescent joint should show. We found that there has been very little work published concerning the epiphyseal-growth area in this region.

However, in Cunningham's Anatomy[1] there appears a description of the development of the sacrum, in which mention is made of the lateral epiphyses of the sacrum. These are small epiphyses which develop along the lateral margins of the sacrum. In observing a large number of pelves in children and adults, we were impressed by the width of the sacro-iliac joints in children as compared with those of adults. Roentgenograms of several individuals, taken both before and after adolescence, showed the wide sacro-iliac joints in childhood and those of normal width in the young adult.

The next problem was to determine what brought about the change. The lateral epiphyses mentioned by Cunningham suggested the answer. We began looking for these epiphyses in the roentgenograms. We have found them, we have seen them appear, and we have watched them fuse to the sacrum. To do this, we have taken stereoscopic plates of normal boys at six-month intervals. On other plates of pelves taken at random, we have seen these epiphyses in various stages of development. From our observations thus far, we believe these epiphyses appear during the fifteenth or sixteenth year, although we have seen them in one patient of thirteen years. In connection with this case, it is interesting to note that the other epiphyses were further advanced than the age of the individual would indicate. These epiphyses are usually fully developed and fused at seventeen or eighteen years of age.

We have also noticed that in some of the pelves one or both sacro-iliac joints may show a cloudy appearance, with some irregular areas of increased density at the site of the lateral epiphyses. In these cases, the joints may be slow in assuming adult appearance, or they may be very irregular, even suggesting pathological

Boston, Mass.

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*Read at the annual meeting of the American Orthopedic Association, Philadelphia, Pennsylvania, June 6, 1935.

changes; yet, the patients have not complained of back symptoms.

Then we have seen the cases which we are now considering. The x-ray findings are variable and at times bizarre, so much so that some of these cases have been considered infectious arthritis, tuberculosis, or osteomyelitis. The joint space is often hazy and irregular; it may have a moth-eaten appearance. At the site of the lateral epiphyses there may be irregular areas of increased density. On account of the depth of the sacro-iliac joints, the anterior margins may overlie the posterior margins in such a way as to confuse the picture and lead to a diagnosis of a destructive bone lesion, such as osteomyelitis or tuberculosis. However, there are no real areas of bone destruction, nor fusion of the joints, such as is seen in cases of infection or arthritis. Usually there is change in both sacro-iliac joints, but the joint on the side which is presenting symptoms usually shows the greater changes. It is interesting also to notice that the symphysis pubis is sometimes slightly out of alignment, suggesting abnormal mobility in one or both sacro-iliac joints.

These changes in the sacro-iliac joints resemble those noticed in Perthes' disease, Osgood-Schlatter disease, and other examples of epiphysitis or apophysitis. We feel that the condition which we have described as "adolescent sacro-iliac" is of a similar nature to that existing in these diseases, and should be differentiated from such lesions as tuberculosis, osteomyelitis, and arthritis.

We are reporting ten cases with a brief description of their clinical history which we believe represent a rather definite clinical entity. One of us (E. M. C.) has been interested in these from the roentgenographic standpoint. Some of these cases have been diagnosed as possible tuberculosis or severe infection.

CONCLUSIONS

Clinically, we are quite sure that there is a tendency to establish a wrong diagnosis and also to carry out too vigorous treatment which only perpetuates the symptoms. This was so in certain epiphyseal conditions of the hip, knee, and spine until it was recognized that injuries and trauma to the epiphysis should be treated by rest. This was also true with reference to the tibial tubercle.

In regard to the development of the epiphyseal centers in and around the sacro-iliac joint, we have not been able to find any extensive work that gives a good description of this joint; therefore, our work is necessarily a clinical description, using the broad term "the adolescent sacro-iliac-joint syndrome."

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Renal Rickets—Report of Case

By Samuel Goldberg, M. D., F. A. C. P., and Joseph L. Candido, M. D., in Arch. Ped., LIV:5:291, May 1937.

In the treatment of bone changes, most writers feel that vitamin D, as viosterol, is of no value and at times definitely harmful. Ultraviolet irradiation is regarded as harmful, because it tends to increase the inorganic phosphorus in the blood. Usually we are dealing with a high phosphorus, low calcium type of rickets, and since vitamin D increases not only the calcium but also the inorganic phosphorus concentration in the blood, the use of viosterol or codliver oil is supposedly contraindicated.

Summary

A boy of six years of age is presented, in whom retardation in growth and development was first noticed at five months of age.

Although the patient received adequate amounts of antirachitic vitamin D, he developed skeletal deformities because of a probable early and persistent renal infection and insufficiency.

The case presented shows renal impairment and urinary tract infection, on which are superimposed bone deformities grossly resembling those of juvenile rickets. Genu valgum or knock-knee is the outstanding manifestation of bone changes found.

Chemical studies of the blood reveal an increased nitrogen concentration with impaired renal function, although we could not demonstrate a disturbed relation between calcium and phosphorus.

The cause of the renal impairment in this case was a bilateral pyohydronephrosis and hydro-ureters, which were noted clinically and confirmed at autopsy.

X-ray studies of the bones reveal more or less the characteristics of juvenile rickets and consist of diminished lime salts, trabeculation, osteoporosis and patchy ossification.

Treatment along antirachitic lines was of no value and at times definitely harmful.

Elliot Treatment in Pelvic Infections

By J. F. Lucas, M. D., F. A. C. S., Greenville, Mississippi, In South. M. J., 30:5:553, May 1937.

Thirty-two cases of acute salpingitis were treated with from 14 to 35 Elliot treatments, the average being 21. Additional therapy included rest in bed, hot water bottle to abdomen, bland diet, bowel hygiene and sedatives as required. In 24, or 75 percent, of cases the results were excellent; they were discharged as clinically cured and free from gonococci. In 5 cases, or 15.6 percent, although there were residual masses in the pelvis following the course of treatments, they were gonococcus and symptom-free and were discharged as improved. Three cases, or 10 percent, although improved, eventually required surgery for relief of symptoms. We feel that greater conservatism of tissue was possible on account of the previous Elliot treatments.

Summary

A consecutive series of 100 cases of pelvic inflammatory and allied diseases are reported in which the principal treatment besides time and rest consisted in the use of prolonged heat by the Elliot technic. A total of 2,008 treatments were given with an average of 20 treatments for each case. In 64 percent of cases the results were considered excellent and these cases were discharged as clinically cured. Twenty-three percent were discharged completely relieved of subjective symptoms and thus avoided major surgical treatment. Thus in 87 percent of cases the results from Elliot treatments alone were satisfactory. Eleven percent of cases were improved by heat treatments which permitted less radical surgery than would have been possible otherwise. Two percent of cases showed no improvement.

It is hoped that these results and the results reported by other authors will increase conservatism in the treatment of pelvic infections and thus reduce the mortality, lessen morbidity, and conserve function of

the pelvic organs of women in their active reproductive life.

Conclusions

1. The Elliot technic is an effective and safe method of applying prolonged heat to the pelvic organs.
2. Satisfactory results may be obtained in the great majority of cases of pelvic inflammatory disease, whether of postpartal, postabortal or specific origin.
3. The latent focus of infection in the cervix is readily cleared up through the effect of heat and increased drainage.
4. In acute gonorrhea, the Elliot treatment is an improvement over former methods in both safety and rapidity of cure.
5. The treatments serve as an invaluable aid in separating the definitely surgical cases from cases in which clinical cure could be obtained by conservative means.
6. When surgery is necessary, the preoperative use of Elliot treatments reduces the extent of operative interference and thereby conserves tissue.
7. The earlier the treatments are started and the more recent the infection, the better the prospects for complete cure.

Postural Deformities of the Anteroposterior Curves of the Spine

Philip Wiles, M. S., Lond., F. R. C. S., Eng., Assistant Orthopedic Surgeon to the Middlesex Hospital, London; in The Lancet CCXXXII:5929:911, April 17, 1937.

Treatment

Before embarking on the treatment of postural deformity, inquiry should always be made into its cause. In cases in which there is no mechanical cause, the factors discussed under aetiology have to be considered. Especially is the question of under-nutrition worth attention; to give remedial exercises to an under-nourished patient is only adding to his troubles. When no other cause is forthcoming, investigation should be made into possible psychological factors. This involves inquiry into the psychological makeup of the patient and his home conditions. In any case of doubt, or when the problem of emotional readjustment is beyond easy solution, it is advisable to obtain the assistance of a medical psychologist. It is of little use to expect a patient to cooperate in remedial work when he is trying to grapple with an emotional problem which is, to him, of much greater importance.

Contracted ligaments and joint capsules may be found preventing correction of dorsolumbar kyphosis or limiting extension of the hips in cases with increased pelvic inclination. The stretching of contracted ligaments, as of any other fibrous tissue, is a matter of difficulty. Forced passive movements, either with or without an anesthetic, result in tearing the ligaments and do more harm than good. The most effective method of stretching them at all rapidly is prolonged traction. Head suspension is, therefore, very valuable when dealing with contractions affecting the spine and, if carefully supervised, is well tolerated by patients. Active movements carried to their extreme range and repeated frequently may be of some assistance in stretching ligaments, but care must be taken to see that the movements are not too violent and to ensure that they are localized to the affected region.

"Shortened muscles" probably play a part in hindering correction of most deformities that are at all severe. The process of increasing the length of muscles is often referred to as muscle-stretching. This is hardly the right word to use because, so far as is known, muscle fibres cannot be stretched—they have to be made to relax more fully. This is not merely an academic point, but a practical one which directly affects treatment. The normal physiological response of a muscle to stretching is contraction, and the harder it is stretched the more strongly it contracts. Therefore passively stretching a muscle calls into action this "stretch reflex" and makes the muscle contract more. The passive stretching of muscles with the idea of lengthening them is a procedure that should be abandoned; it can do no good, and, if carried to an extreme, it will do harm.

The lengthening of a muscle can be achieved by getting it to relax more fully.

The establishment of new postural reflexes is the final aim of all remedial treatment. It is just here that so many systems, including that officially recognized in this country, show their greatest weakness. They are mainly concerned with strengthening muscles and increasing mobility and make but little effort to teach the patient how to hold the new posture. Remedial work requires "postural fixation" not "postural change," so, when it is possible to make a voluntary correction, exercises that move the parts of the body principally concerned can do no good. Exercises must be directed towards keeping those parts as still as possible while the rest of the body is moved. Thus the patient is taught to keep a good posture during every variety of movement.

It would be out of place to attempt to describe here any particular remedial system that will fill the criteria set out. It requires but little ingenuity to invent one once the principles are understood. I am concerned mainly to emphasize that it is not movement, but absence of movement, of any given part that is essential for the establishment of a postural reflex. Success or failure of treatment depends on the extent to which the cooperation of the patient is obtained. During the remedial class it is only possible to teach the patient how to get into the new posture and how to hold it under a variety of conditions. The establishment of an unconscious reflex that will hold the new posture permanently is possible only if the patient continues to try after the class is over, and it can never be done if, as soon as he is out of the room, he just drops back into the old posture. For treatment to be successful the patient must really want to be cured and make up his mind to succeed. The personality of the teacher and his ability to win the patient's confidence and keep his interest is of just as great importance as a knowledge of remedial technique.

Summary

The regulation of posture is a function of the central nervous system which determines the length at which the muscles are habitually held; the strength of the muscles is of less importance.

The importance of rapid growth, undernutrition, and psychological factors in the aetiology of postural deformities is emphasized.

A new instrument is described for measuring the pelvic inclination. This angle in "normal" adult males averages 31 degrees, and in females 28 degrees. In children it is somewhat less, but it increases up to 11 years of age when the adult level is reached.

The pelvic inclination is regulated by the muscles surrounding the hip joint, and not by the trunk muscles.

Deformities are classified on the basis of their two principal components—variation in pelvic inclination and

the presence or absence of a dorsolumbar kyphosis—into four types: (1) lumbar lordosis; (2) sway back; (3) flat back; (4) round back.

Final correction of a deformity can be made only by establishing new postural reflexes. This can never be done by movement, but only by absence of movement; therefore, exercises must be designed to keep still the parts of the body concerned.

The Influence of Muscular Exercise on Blood Sugar Concentrations

Florence H. Smith and Kendrick A. Smith, in J. Clin. Invest., XVI:3:289, May 1937. (From the Department of Medicine, University of Chicago, Chicago.)

This paper reports the observations made on the effect of muscular exercise on the blood sugar of twenty-seven subjects. Twelve had diabetes mellitus treated with insulin; four diabetes mellitus treated without insulin; three renal glycosuria, one of which was on insulin therapy; two hypotension; and one each glycosuria of pregnancy, obesity, and epilepsy; while three were normal individuals.

Exercise of sufficient intensity and duration will lower the postprandial blood sugar in controlled diabetes mellitus treated with or without insulin, in renal glycosuria, in hypotension, in obesity and in normal subjects.

Exercise in the uncontrolled diabetic, in the amounts performed in these experiments, does not have a noticeable effect in lowering the postprandial blood sugar.

Exercise seems to have the greatest effect in lowering the postprandial blood sugar in the irregularly controlled diabetic, when measured by the difference in resting and exercising blood sugar levels at the end of exercise, and by the resulting clinical symptoms at this time.

Exercise of the intensity performed in these experiments is not sufficient to lower the blood sugar below the normal fasting levels in non-diabetics.

The Psychological Aspects of Physiotherapy

William C. Menninger, M. D., and Mildred Cutrer, R. N. in Am. J. Psychiatry, 93:4:909, January 1937.

From our observations in the application of physical therapy to persons with mental illness, the psychological effects of such treatment often appear to be the most beneficial influence in the procedures. We are well aware of the physical benefits to be derived, whether the treatments are given for the purpose of sedation or elimination, stimulation or tonic effects. It is noteworthy, however, to the physician or nurse interested in the application of physical therapy in the psychiatric hospital that almost no mention of this very important feature of physical therapy is made either in the periodical literature or the standard texts. Most of the recent papers on this subject and even the excellent text by Wright fail to give any specific attention to this feature of physical therapy. Although Kindwall and Henry attempt to evaluate the effectiveness of wet packs and prolonged baths, they make no comment on the specific point of the psychological influence; rather, they discuss the patient's attitude toward the treatment. Wallace frankly states that it is the psychic attitude that has in part at least accounted for the success of health resorts and spas.

This failure to mention the psychological benefits to be derived from physical therapy is the more paradoxical when one considers the very obvious facts of medical history and even of present day practice.

Summary

The psychological effects obtained from physical therapy depend largely upon the personality of the therapist, her understanding of the psychologic needs of the individual and her ability to direct therapy to meet these. In the treatment of mental diseases the value of physical therapy results only in part (probably a minor part in some instances) from the physical effects but rather from the psychological effects which it produces.

The fact that all mental institutions, no matter how small, have some kind of a physical therapy department gives one an opportunity to stress the point that physical therapy is of great help in producing improvement in mentally ill patients.

The Effect of Heat on Blood and Lymph Flow From the Gastro-Intestinal Tract

J. M. Beazell, C. R. Schmidt, and A. C. Ivy, in Am. J. Physiol., 119:1:197, May 1, 1937. (From the Department of Physiology and Pharmacology, Northwestern University Medical School, Chicago, Illinois.)

Heat was applied at various levels of the gastrointestinal tract of dogs by means of an Elliott Treatment Regulator. In essence this apparatus consists of a thermostatically controlled water bath and an electrically driven pump which circulates the water through a tubular, soft gum rubber, slightly distensible applicator. The applicators are interchangeable so that the size and shape can be varied to conform with the organ to be treated.

Summary and Conclusions

Heat was applied to the lumen of isolated segments of the small intestine and the colon at temperatures ranging from 52.2° to 57.7°C. by using a specially devised hollow rubber applicator. Under these circumstances the rate of flow of blood through the treated tissue was markedly augmented, unless the mucosa was injured. In some experiments the rate of flow was doubled and in others it was quadrupled. This procedure had no measurable effect on the rate of flow of lacteal lymph. However, the secretion of succus entericus was markedly augmented.

Temperatures of 52.2° C. were applied to the lumen of the stomach without effecting the flow of lymph from the thoracic duct.

Burns occurred in three out of four experiments in which the applicator was of such size that it distended the segment, or caused it to contract vigorously. The contractile response of the colon rendered it more sensitive than the small intestine to the injury produced by the heat of the relatively too large applicators. Injury resulted in a decrease in blood flow and an increase in lymph flow.

Ultraviolet Irradiation: Technique of Application

A. P. Cawadias, O. B. E., M. D., F. R. C. P., Physician to the St. John Clinic and Institute of Physical Medicine; in British J. Phys. Med., 11:12:225, April 1937.

The following is a typical course for suberythemal doses:

First irradiation:—Distance of lamp, three feet. Time of irradiation, three minutes.

Second irradiation:—Two days afterwards. Search for any reactions. If any erythema has occurred, the lamp is moved to a distance of four feet, or the time is decreased to two minutes for this irradiation. If ery-

thema has not occurred the distance is diminished to two feet, maintaining the same duration of irradiation. Or the lamp is kept at the same distance and the time of irradiation is increased by one minute.

Third irradiation:—Two days after the second irradiation. Again constitutional and local reactions are noted. If no erythema is present the time of exposure is increased by one or two minutes. At the fourteenth irradiation, for instance, an exposure of fifteen minutes is reached at a distance of three feet. We must stop at the fourteenth or fifteenth irradiation. Long continued treatments are not necessary and may even be harmful.

Technique of application of erythematous doses needs the same preparation as that for suberythematous doses. The principal point is increase of the time of irradiation and also shortening of the distance between lamp and patient.

It is necessary to point out that among the preparations for this mode of irradiation constitutional examination of the patient must be stressed. Erythematous doses are shock treatments, and shock must not be applied to patients who are very weak and therefore cannot tolerate it.

Before starting irradiation we must know our apparatus thoroughly, particularly its power of determining erythema. In certain cases we can use instruments of accuracy, like Saidman's sensitmeter. Unfortunately this, although a very good instrument, has not come into general use in English-speaking countries. A simpler method is for the physician to test the apparatus on himself. He can irradiate a small surface of his arm and try to find out with how many minutes and at what distance erythema is produced. This assesses the erythema-producing dosage of his apparatus, which must be ascertained before treatment is begun.

Therapeutic Approach in Mental Disorders Through Physical Therapy

Edward Scharf, M. D., Veterans' Administration Facility, Northport, Long Island; in Med. Bull. Vet. Admin., 13:4:338, April 1937.

The aim of every therapist in a neuropsychiatric institution is to follow up the psychotic patient immediately after the appropriate treatment has reduced the excitement and the patient has become more accessible and potentially modifiable through resocializing therapeutic adjuncts. This second stage of treatment has as its objective the rehabilitation of the patient through a balance of endeavor, where heretofore there has been an imbalance.

The author feels that physical therapy or play therapy properly prescribed by the neuropsychiatrist has an appeal in certain classes of mental disorders, especially to the male patient. It is not meant that physical therapy should supplant occupational therapy or industrial therapy, but to act as an adjunct or supplemental form of treatment. As a result of actual experience and observation over a number of years, it is thought that there is no procedure that brings out a more normal rapport between the psychotic and the world than a game of volley ball, baseball, golf, code ball, tennis, horseshoes, croquet, etc. Play appears to reestablish the confidence and loss of initiative that is so prevalent in our psychotics or border-line cases. Some psychiatrists have the belief that disuse of function, rather than loss of function, may account for the relatively weak initiative and poor effort of the schizophrenic.

In organizing these accessory therapy measures it appears advisable to seek to reestablish old habit patterns associated with pleasurable emotions rather than to try to teach new things. Reeducation rather than education seems to be the valid objective. It is surprising to note the interest that even an apparently regressed schizophrenic shows when informed that he is to play in scheduled games. It is significant that the personnel in charge state that those who participate in athletics take more interest in their work and really receive much more benefit from industrial therapy. Especially it is noted that under prescribed physical therapy the psychotic shows a better intramural adjustment, appears to have more confidence in himself, and presents a more normal and satisfactory behavior.

Physical therapy can be looked upon from two aspects: as a physical procedure for physical readjustment; and as a social procedure for the resocialization of the functional cases, and restoration as far as practicable to a higher social adaptation, of the organic cases. For the psychotic patient, play should be viewed primarily as an attempted resocializing process.

Summary

Physical therapy should be viewed primarily as an adjunct resocializing medium.

It should be prescribed by the psychiatrist and carried out by a specially trained physical director.

Observation and experience appear to confirm the belief that play has some distinctive appeal to the psychotic patient and will often stabilize him when other methods fail.

Play appears to be an effective medium of starting the patient into therapeutic activity.

Play properly prescribed and administered undoubtedly makes the patient more receptive to other forms of treatment.

The patient improves most who engages in a balanced regimen of work, rest, and play.

The Exchange of Salt and Water Between Muscle and Blood

Editorial, Jour. A.M.A., 108:22:1893, May 29, 1937.

By an ingenious combination of analysis and calculation, Eichelberger and Hastings have thrown much light on the fundamental processes involved in the exchange of salt and water between muscle and blood. Their experiments were of necessity conducted in living animals, since they found that excised muscle quickly undergoes changes in permeability which destroy the physiologic meaning of observations on such tissues in vitro. They found that normal muscle, calculated on a fat-free basis, consists of about 17 per cent of interstitial fluid, by weight, and about 83 per cent of cells. The water content of the whole muscle averages 76.5 per cent and of the cells 71.7 per cent, the variations from the average being hardly greater than in the case of serum. That muscle cells contain little or no sodium or chloride had previously been suspected; their observations leave little doubt that this is the case and that the cells must be considered impermeable to these ions as well as to those of potassium.

Of special interest is their demonstration that simple fluid excess, uncomplicated by acidosis or alkalosis, results in an increase in the intercellular fluids without either swelling or shrinkage of the cells. Some swelling of the cell occurs when alkalosis is induced by overbreathing, while acidosis induced by rebreathing of expired air results in shrinkage of the cells. It is noteworthy, however, that except under extremely abnormal conditions the changes in volume observed, either of the cells or of the interstitial fluids, were relatively small.

These results would appear to cast doubt on the view that either acidosis or alkalosis is actively concerned with the occurrence of clinical edema.

Infections of the Fingers and Palm

Sumner L. Koch, M. D., Chicago. Pennsylvania M. J., 40:8:597 (May) 1937.

A few surgical principles are applicable to the treatment of all infections of the hand, and to avoid repetition it may be worth while to emphasize them at the outset:

1. In preparing the field of operation there is nothing more effective than soap and water to cleanse the skin and to get rid of desquamating epithelium and coagulated wound secretion. Preoperative application of tincture of iodine or other powerful antiseptics only adds to postoperative maceration and necrosis of superficial tissues, particularly if warm wet dressings are used after operation.

2. A general anesthetic is always to be preferred to a local or freezing procedure.

3. The great advantage of a bloodless field, easily obtained with the help of a blood-pressure apparatus, should always be kept in mind. It permits the surgeon to make accurate incisions, to make certain that drainage is adequate, and to avoid injury of important structures—nerves, blood vessels, tendon sheaths—which are essential to the function of the hand.

4. The use of drainage material which favors and does not prevent escape of wound secretion and which can be removed with a minimum of discomfort to the patient deserves consideration. A small wedge of gauze saturated with petrolatum can usually be inserted in one corner of the wound in such a way as to hold tough and rigid skin edges apart and still not prevent escape of wound secretion. Failure to provide some method of holding wound edges apart may permit agglutination of the edges of the incision and tempt the surgeon to probe the wound day after day, with unsatisfactory results as far as drainage is concerned and with unfortunate results to the patient's morale and the surgeon's reputation. Although drains of gauze saturated with petrolatum are of definite value, rubber tubes and firm unyielding drainage material have no place in the care of infections of the hand. They invariably cause necrosis and destruction of tissue.

When the drain is removed at the end of 24 or 48 hours, it should not be replaced. There is no more certain way of adding further infection to the open wound than by the repeated insertion of drains. If the original incision is adequate and correctly placed, reinsertion of a drain should not be necessary.

5. After operation for infection a large dressing is applied to enclose the entire hand and forearm if the infection is more than a paronychia, and the entire upper extremity if there is evidence of rapid extension. The dressing is kept moist by the addition from time to time of sterile salt solution or boric solution. Heat is maintained with the aid of an electric baker or cradle, or by some form of heat lamp. It is futile to attempt to keep a dressing warm by repeated applications of a hot solution. The dressing soon becomes cold as a result of rapid evaporation, and the patient becomes wretched and uncomfortable from lying in a water-soaked bed.

6. Except for the occasional addition of small amounts of the sterile solution, the dressing is left undisturbed for 24 hours. At the end of that time it is changed and a fresh dressing applied with the same care as regards asepsis that was used in the operating room. In treating an acute spreading infection it is vitally important to practice scrupulous cleanliness and so avoid adding another strain of bacteria to those already present. The development of resistance to a virulent infection, already difficult for a debilitated patient, may become impossible if secondary infection from some outside source is added as a result of unskillful or careless dressing of the open wound.

7. Even in simple and localized infections the importance of conserving function should be kept in mind from the outset of treatment. After 48 or 72 hours the continuous warm wet dressing often can be replaced by intermittent soaking of the hand in the sterile hand bath for 20 or 30 minutes once or twice daily. Following each soaking the hand is laid on a sterile towel and dried out under a light or baker for 30 minutes. During these procedures the patient is urged to carry out active movement of fingers and hand through their normal range of motion 2 or 3 times daily. Such movement is sufficient to prevent the stiffness that develops rapidly in an inflamed and completely immobilized hand. When the dressing is reapplied it is made just large enough to cover the affected area securely. Uninvolved fingers are left free so that the patient can use them and avoid the loss of function of unaffected fingers that so often follows unnecessary and long-continued immobilization of the entire hand.

The Influence of Strenuous Muscular Exercise Upon Renal Excretion

Earl R. Norris, and Russell S. Weiser, in Am. J. Physiol., 119:3:642, July 1, 1937.

From the Department of Biochemistry, University of Washington, Seattle, Washington.

Conclusions

During and following muscular exercise there is a marked decrease in the excretion of creatinine as well as the other urinary constituents, total nitrogen, uric acid, chlorides and inorganic phosphates.

The depression of urinary excretion following exercise is influenced by the severity of the exertion relative to the maximum ability and training of the individual.

The extent and duration of the period of depression of excretion of the various urinary constituents varies for each individual substance and is not dependent upon the rate of water excretion.

The recovery from the condition of decreased rate of excretion is much more rapid in the case of creatinine than of uric acid.

The results of the experiments presented indicate that the decreased rate of excretion during and immediately following severe exercise is due to renal impairment.

Automatic Control of Continuous Bath

Walter E. Lang, M.D., Superintendent of Westborough State Hospital, Westborough, Mass., in Am. J. Psychiat., 93:4:937, January 1937.

In the spring of 1932, when about to make an installation of a new six-tub continuous bath unit at the Westborough State Hospital, it was decided to experiment and, if possible, to produce an apparatus that would accomplish the following:

Automatically maintain, at a predetermined temperature, the water actually in contact with the patient's body.

Make a permanent record of that temperature.

Provide additional means for protecting the patient from high temperatures due to mechanical failure or human carelessness.

Conserve water.

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THE MENSENDIECK SYSTEM OF FUNCTIONAL EXERCISES. By Bess M. Mensendieck. Cloth. Price, $12. Pp. 154, with 68 illustrations and 11 colored plates. Portland, Maine: The Southworth-Anthoensen Press, 1937.

This volume, the first of a series of three, presents and explains in minute detail three exercise sequences for educating the musculature according to the mechanical laws that underlie its operation, and for improving the muscle-automatisms that are used for performing every day movements, so that their effect upon the body architecture may be constructive. The author believes that one of the features which seems to be almost entirely lacking in our present-day schemes of physical education is the training needed for visually appreciating the beauty of perfect movement *per se* and for deriving the justifiable esthetic satisfaction that is obtainable therefrom.

This volume presents the author's ideas to remedy this defect. The text and the illustrations certainly prove that there can be a skillful management of the body itself through a master of the science of movement whereby muscles are made to act upon bones in right functional sequences and in perfect accord with the laws of body-mechanology.

The author deals exhaustively with commonplace everyday movements which she believes should form the basis of all body education. It would seem from this volume that the Mensendieck System by its careful analytical study and training of the muscle mechanisms that operate to produce ordinary everyday movements can without apparatus, playing fields, game, instruments or music, gradually build the body to a point of working perfection.

It is emphasized that through adequate body knowledge an individual can direct his will-power into exactly those muscles needed for a movement. We must become muscle conscious in order to differentiate between the use of right and wrong muscles. These exercises are to train the repeated conscious choice of right muscles which will lead eventually to habits of movement that are automatically correct.

The description of the Mensendieck Preparatory Position is the best described and the best illustrated article on correct body mechanics that we have seen. The rhomboideus, pelvic-rocking and the round forward trunk-bending exercises are also described in this volume.

This is a quarto-size volume with large, clear type and beautiful illustrations. It should be in the library of everyone interested in exercises.

SAFEGUARDING MENTAL HEALTH. By Raphael C. McCarthy, S. J., Ph. D., President of Marquette University. Cloth. Price, $2.50. Pp. 297. New York, Milwaukee and Chicago: The Bruce Publishing Company, 1937.

At the present time people are thinking and talking about mental disturbances with a familiarity rarely exhibited in the past. The bookstands are showing an increasing number of publications dealing with human behavior and the reasons for success or failure. Much of this literature is extremely vague, pseudo-scientific or very poorly presented. It is, therefore, exceedingly gratifying to have available so excellent a book as "Safeguarding Mental Health." This book is written for the average reader who has an interest in the subject of mental health without a special formal training in psychology or psychiatry. As a result the material is discussed in an extremely simple manner, yet adequately covering many important aspects of mental hygiene and the more common problems of "nervousness."

After giving a brief discussion of the factors usually associated with the production of mental difficulties, the author stresses measures of prevention. There are several chapters on the problems of the child which are particularly well described. The early experiences of the child in relation to his environment determine in great measure the future adult personality. The nature of this

early conditioning is of fundamental significance in the development of later neuroses. The role of emotional conflicts and phobias giving rise to "complexes" is discussed with unusual clarity. The author has attempted to outline a few general concepts whereby a happy "way of life" may be achieved in spite of the vicissitudes which must be encountered in this difficult modern age. This book should be beneficial to the reader regardless of his special interests.

INJURIES AND DISEASES OF THE HIP. By Dr. Fred H. Albee assisted by Dr. Robert L. Preston. Price, $5.50. New York: Paul B. Hoeber.

Dr. Albee has centered his attention on the hip in a monograph which brings to date the available knowledge of injuries and diseases of this region. His virile, direct style is admirably suited to the presentation of his own theories and methods, which are the nucleus of the book. Generous quotations and references serve to include rival views and procedures with critical comment by the author.

Details of technic and anatomy are dealt with in separate chapters. The section on fractures furnishes a critical analysis of the present methods which should go far toward clarifying the subject. The chapter on tuberculosis is particularly exhaustive and scholarly. Other infections, dislocations, coxa vara, osteo-arthritis, and the less common affections are dealt with at appropriate length. Arthroplasty, arthrodesis, reconstruction, bone graft peg, and shelf operations are discussed in detail and are well illustrated.

Most valuable as an operative surgery, the book includes such excellent expositions of etiology, pathology, tabular differential diagnoses, and outlines of conservative treatment that it must be hailed as "a complete survey of the problem of hip disease." Doubly indexed, it will excel as a reference work for students as well as an operative guide for orthopedic surgeons.

SEX LIFE IN MARRIAGE. By Oliver M. Butterfield, M. A. Foreword by Sophia J. Kleegman, M. D., F. A. C. S., Assistant Clinical Professor, Obstetrics and Gynecology, New York University, College of Medicine. Cloth. Price, $2. Pp. 192, with 4 illustrations. New York: Emerson Books, Inc., 1937.

Previously only the psychiatrist recognized the importance of the sex factor in influencing the behavior of the adult. The many tragedies unfolded behind his doors filled his files with human documents held private and secret. At the present time, however, a more enlightened public is beginning to appreciate the importance of having adequate knowledge regarding this vital phase of human behavior and are welcoming sane and helpful information. This book is an excellent answer to the need for such material. The author traces the origin of the sexual urge up to its present status in this civilized world. Ignorance regarding not only the psychologic aspects of sexual relations but even the simple mechanics of intercourse is so frequently the cause of marital discord and failure. The subject is approached in a very simple, straightforward manner which should be readily understood by the average reader. The author, a member of the clergy, has combined excellently scientific truths with modern moral standards, and one cannot help but profit by reading this concise but informative treatise.

ELEMENTS OF ORTHOPEDIC SURGERY. By N. Ross Smith, M. B., Ch. M. (Sydney), F. R. C. S. (Eng.); Orthopedic Surgeon, Cornelia Hospital, Formerly Surgical Registrar, West London Hospital, Surgical Registrar and Senior House Surgeon, Royal National Orthopedic Hospital, London; Demonstrator in Anatomy, University of Sydney. Foreword by R. C. Elmslie, O. B. E., M. S., F. R. C. S., Orthopedic Surgeon, St. Bartholomew's Hospital, Consulting Surgeon, Royal National Orthopedic Hospital, London; Past President, British Orthopedic Association, Chairman of Council, Chartered Society of Massage and Medical Gymnastics. Cloth. Price, $4. Pp. 246, with 99 illustrations. Baltimore: William Wood and Co., 1937.

According to the foreword the organization of orthopedic treatment has become a matter of considerable complication in England as well as in the United States. There, as well as here, many individuals other than specialists are concerned with this care. Some are members of the auxiliary professions of nursing, massage, and appliance making, and many are laymen, without any medical training or knowledge. Elmslie believes that physical education may be classed as a preventive side of orthopedics. He also believes that all these groups require a general idea of the objects and methods of orthopedic treatment. This is the aim of this book.

Only the common conditions treated by orthopedic methods are described. This is written very clearly so that it can be easily understood by these various groups. In the introductory chapter the organization of cripple welfare work is discussed. There are chapters on congenital and postural deformities, rickets, diseases of the nervous system, rheumatic diseases, tuberculosis of bones and joints, miscellaneous bone and joint diseases, general considerations of fractures and injuries to nerves, muscles, tendons and joints. In the appendix there are brief presentations of the principles of physical therapy, splints and appliances, and plaster of Paris technique. This volume can be recommended to nurses and laymen engaged in cripple welfare work.

MATERNITY AND POST-OPERATIVE EXERCISES. By Margaret Morris, C. S. M. M. G., in collaboration with M. Randell, S. R. N., S. C. M., T. M. M. G. Introduction to Maternity Exercises by Professor R. W. Johnstone, C. B. E., M. D., F. R. C. S. E., F. C. O. G., and Introduction to Post-Operative Exercises by Professor John Fraser, M. C., M. D., F. R. C. S. E. Cloth. Price, $2. Pp. 152. New York: Oxford University Press, 1936.

In the two introductions and in the first three chapters of this book the physiological and psychological value and the general and special aims of antenatal, postnatal and post-operative exercises are thoroughly considered. All the exercises are clearly explained and illustrated with line drawings. There is a chapter on breathing and posture. The breathing described here has formed a basic part of all Margaret Morris Movement exercises for the past fifteen years.

This volume is intended for physical therapists and nurses, so the greater part is devoted to definite instructions for the teaching of the exercises and useful positions of rest. There can be no doubt that a patient who is taught these exercises will make a quicker and more complete recovery than she would otherwise. This book can be recommended to all who are interested.

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